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SOME FURTHER APPLICATIONS OF THE METHOD OF POSITIVE RAYS[1]

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THE method to which I shall refer this evening is the one I described in a lecture I gave here two years ago. The nature of the method may be understood from the diagram given in Fig. 1. *A* is a vessel containing the gases at a very low pressure; an electric discharge is sent through these gases, passing from the anode to the cathode *C*.

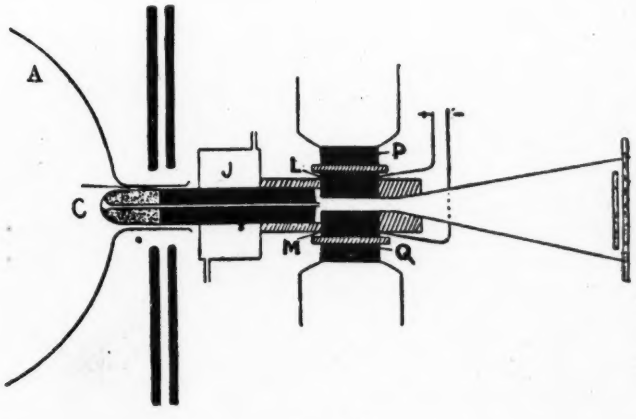


FIG. 1.

The positively electrified particles move with great velocity towards the cathode; some of them pass through a small hole in the center, and emerge on the other side as a fine pencil of positively electrified par-

[1] Address before the Royal Institution of Great Britain, Friday, January 17, 1913.

ticles. This pencil is acted on by electric forces when it passes between the plates L and M, which are connected with the terminals of a battery of storage cells, and by a magnetic force when it passes between P and Q, which are the poles of an electro-magnet. In the pencil before it passed under the influence of these forces there might be many kinds of atoms or molecules, some heavy, others light, some moving quickly, others comparatively slowly, but these would all be mixed up together. When they are acted on by the electric and magnetic forces, however, they get sorted out, and instead of traveling along the same path they branch off into different directions. No two particles will travel along the same path unless they have the same mass as well as the same velocity; so that if we know the path of the particle we can determine both its mass and its velocity. In chemical analyses we are concerned more with the mass than with the velocity, and we naturally ask what is the connection between the paths of particles which have the same mass but which move with different velocities. The answer is that all such paths lie on the surface of a cone, and that each kind of particle has its own cone; there is one cone for hydrogen, another for oxygen, and so on. Thus one cone is sacred to hydrogen, and if it exists there must be hydrogen in the vessel; so that if we can detect the different cones produced from the original pencil, we know at once the gases that are in the tube. Now, there are several ways of identifying these cones, but I shall only refer to the one I have used in the experiments I wish to bring before you this evening. These moving electrified particles, when they strike against a photographic plate, make an impression on the plate, and a record of the place where they struck the plate can be obtained. Thus, when a plate is placed in the way of the particles streaming along these cones, the sections of these cones by the plate (parabolas) are recorded on the photograph, hence we can identify these cones by the parabolic curves recorded on the photograph, and these parabolas will tell us what gases are in the vessels.

The first application of the method which I shall bring before you this evening is to detect the rare gases in the atmosphere. Sir James Dewar kindly supplied me with two samples of gases obtained from the residues of liquid air; the samples had been treated so that one might be expected to contain the heavier gases, the other the lighter ones. I will take the heavier gases first. The photograph for these is shown in Fig. 2. When the plate is measured up it shows a faint line corresponding to the atomic weight 128 (xenon); a very strong line corresponding to the atomic weight 82 (krypton), a strong argon line 40 (argon) and the neon line 20. There are no lines unaccounted for, and hence we may conclude that in the atmosphere there are no unknown gases of large atomic weight occurring in quantities comparable with those of xenon or krypton. This result gives an example

of the convenience of the method, for a single photograph of the positive rays reveals at a glance the gases in the tube. I now turn to the photograph of the lighter constituents shown in Fig. 3; here we find the lines of helium, of neon (very strong), of argon, and in addition there is a line corresponding to an atomic weight 22, which can not be identified with the line due to any known gas. I thought at first that this line, since its atomic weight is one half that of CO_2, must be due to a carbonic acid molecule with a double charge of electricity, and on some of the plates a faint line at 44 could be detected. On passing the gas slowly through tubes immersed in liquid air the line at 44 completely disappeared, while the brightness of the one at 22 was not affected.

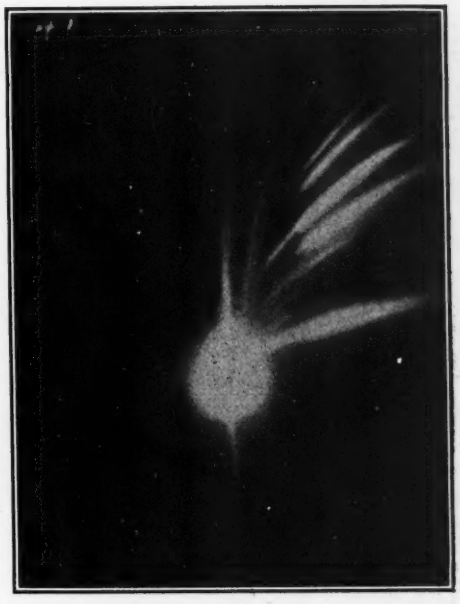


FIG. 2.

The origin of this line presents many points of interest; there are no known gaseous compounds of any of the recognized elements which have this molecular weight. Again, if we accept Mendeleef's periodic law, there is no room for a new element with this atomic weight. The fact that this line is bright in the sample when the neon line is extraordinarily bright, and invisible in the other when the neon is comparatively feeble, suggests that it may possibly be a compound of neon and hydrogen, NeH_2, though no direct evidence of the combination of these inert gases has hitherto been found. I have two photographs of the

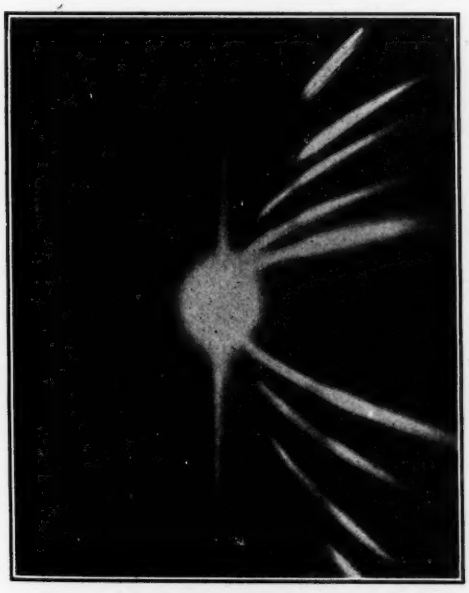


FIG. 3.

discharge through helium in which there is a strong line, 6, which could be explained by the compound HeH_2, but, as I have never again been able to get these lines, I do not wish to lay much stress on this point. There is, however, the possibility that we may be interpreting Mendeleef's law too rigidly, and that in the neighborhood of the atomic weight of neon there may be a group of two or more elements with similar properties, just as in another part of the table we have the group iron, nickel and cobalt. From the relative intensities of the 22 line and the neon line we may conclude that the quantity of the gas giving the 22 line is only a small fraction of the quantity of neon.

Let me direct your attention again to the photograph of the heavier gases in the atmosphere. You will notice that the parabolas corresponding to many of the elements start from points which are all in the same vertical line; this indicates that the atoms or molecules which form these parabolas all carry the same charge. Several of these lines, however, do not follow this rule; you will notice, for example, that the neon line has a prolongation which comes nearer than the normal line to the vertical line drawn through the undeflected spot. Measurement of the photograph shows that the neon line begins at a distance from this vertical line which is only half the normal distance; this shows that some of the neon atoms in the positive rings possess two charges of electricity; the majority of them, however, only possess one. If you examine the argon line you will find that it comes even nearer to the vertical than the neon line, in fact, it begins at a distance from the vertical only one third of the normal distance; this proves that the argon atom can have as many as three charges of electricity. If now you examine the krypton line you will find that it comes nearer to the vertical line than even the argon; its least distance is one fourth of the normal distance, showing that the krypton atom may have as many as four charges. The mercury line comes so close to the vertical line that it is only on large photographs that it can be seen that there is in reality an interval; this interval is only one eighth of the normal interval, showing that mercury may acquire eight positive charges, *i. e.*, that it may lose eight corpuscles. The mercury atom when it is on this line must have only the normal charge, *i. e.*, it must have regained all but one of the corpuscles it previously lost; if it had retained two positive charges it would have been on the line corresponding to the atomic weight 200/2 or 100; if it had retained 3, or 4, 5, 6, 7, 8 on the lines corresponding to the atomic weights, 200/3, 200/4, 200/5, 200/6, 200/7, 200/8 respectively. All these except the last have been detected on the plate. The lines corresponding to the multiple charges on krypton, argon and neon have also been detected. It appears, then, that in a vacuum tube a mercury atom, for example, may be ionized in two ways; in the one way the atom loses one corpuscle, in the other it loses eight.

I would suggest that these two types of ionization may result from the two different types of collision which the atom must experience. The first type is collision with a corpuscle; since the corpuscle is an exceedingly small body moving with a very great velocity, it can pass freely through the atom, and the collision it makes with the atom is really a collision with a corpuscle inside the atom; this may result in the corpuscle it strikes acquiring such a great velocity that it is able to escape from the atom; this type of collision will result in the detachment of a single corpuscle. The second type of collision is when the atom collides with another atom and not with another corpuscle; the result of this collision may be that the atom suffers a sudden change in its velocity. This change is not at first shared by the corpuscles, so that these just after the collision may have a very considerable velocity relative to the atom. If there are several corpuscles which are comparatively loosely attached to the atom, these may all be detached from it and leave it with a positive charge corresponding to the number shaken out. It is this type of collision which we regard as giving the multiply-charged ions, and we see that the magnitude of the charge is a measure of the number of corpuscles in an atom which are readily detachable from it. We have seen that the greater the atomic weight the greater the charge it can acquire, the maximum charge being roughly proportioned to the square root of the atomic weight, hence the heavy elements have a larger number of detachable corpuscles than the lighter ones.

Another application of the method I should like to bring before you is the use of it for the discovery and investigation of a new substance. I have in previous lectures said that sometimes there appeared on the plates a line corresponding to a particle with an atomic weight 3; this must either be a new element or a polymeric modification of hydrogen, represented by H_3. The other possibility that it is a carbon atom with four charges is put out of court by the fact that it frequently occurs when the carbon line is exceedingly faint, and when there is not a trace of a carbon atom with even two charges, though the doubly-charged carbon atom occurs readily under certain conditions. In addition to this, the carbon atom parabola never approaches the vertical near enough to allow of its having four charges. I thought the study of the substance producing this line would be of interest, and I have for some time been working at it, and although the research is by no means completed, I have obtained some results which I should like to bring before you.

At first I was greatly hindered by not knowing the conditions under which the line occurred; although it appeared from time to time on the plates, its appearance was always fortuitous and sometimes for weeks together the plates would not show a trace of the line. The line sometimes appeared, but why it did so was a mystery, and I could not get it when I wanted it. I began an investigation, which proved long and

tedious, to find the conditions under which the line appeared. I tried filling the discharge-vessel with all the gases and vapors described in the books on chemistry without success. At last I tried bombarding various substances with cathode rays. Under this treatment the substances give off considerable quantities of gas the greater part of which is hydrogen, carbonic acid or carbon monoxide. When I came to analyze by the positive rays the gases given off in this way, I found that with a large number of substances these gases contained the substances giving the three lines, so that I was now in a position to get this line whenever I wanted it, and investigate the properties of the gas to which it owes its origin. The question of the gases absorbed and given off by solids is an extremely interesting one, and a considerable number of investigations have been made on it. In all these, as far as I know, the method has been to heat the solid to a high temperature, and then measure and analyze the very considerable amount of gas which is driven off by the heating. As far as I know, no experiments have been made in which the gases were driven off by bombardment with cathode rays. This treatment, however, will cause the emission of gas even when ordinary heating fails to do so.

Belloc, who has recently published[2] some interesting experiments on this subject, after spending about six months in a fruitless attempt to get a piece of iron in a state in which it would no longer give off gas when heated, came to the conclusion that, for practical purposes, a piece of iron must be regarded as an inexhaustible reservoir of gas. There are some interesting features about the emission of gas from a heated solid. If the body is kept for a long time in a vacuum at a high temperature, the emission of gas becomes too small to be detected; if after this treatment the temperature is raised considerably, there will be a further copious emission of gas, which again diminishes as the heating continues. After it has fallen to zero, all that is necessary is to raise the temperature again and you will get a fresh supply of gas; and as far as my experience goes, after you have got all the gas you can out of the solid by heating it, you have only to expose it to cathode rays to get a fresh outburst. This effect of increased temperature in renewing the stream of gas from the solid seems to me to be too large to be accounted for merely by an increase in the rate of diffusion of the absorbed gas from the interior to the surface; it seems to be more analogous to the case of the emission of the water of crystallization from some salts. There are some salts, for example, copper sulphate, which when heated lose their water of crystallization in stages; thus, if the temperature is raised to a certain value, some of the water of crystallization comes off, but the rest remains fixed, and you may keep the salt at this temperature for ever without getting rid of all the water of crystallization; on

[2] *Ann. de Chimie et de Physique* (8), XVIII., p. 569.

raising the temperature, however, fresh water of crystallization is given off. Something of this kind seems to take place in the case of gases absorbed in metals, and there seem to be indications that there is some kind of chemical combination between the gas and the metal. This absorbed gas may influence the behavior of the substance. For example, an ordinary carbon filament gives off, when raised to a white heat, large quantities of negatively electrified corpuscles; but Pring and Parker[3] have shown that when great precautions are taken to get rid of the absorbed gas, the emission of these corpuscles falls to less than one millionth of their previous value. It is in the gases given off by certain metals when they are bombarded by cathode rays that I have found an unfailing source of the substance, which I shall denote by X_3, giving the line corresponding to the atomic weight 3. The arrangement I have used for investigating the presence of this gas is shown in Fig. 4.

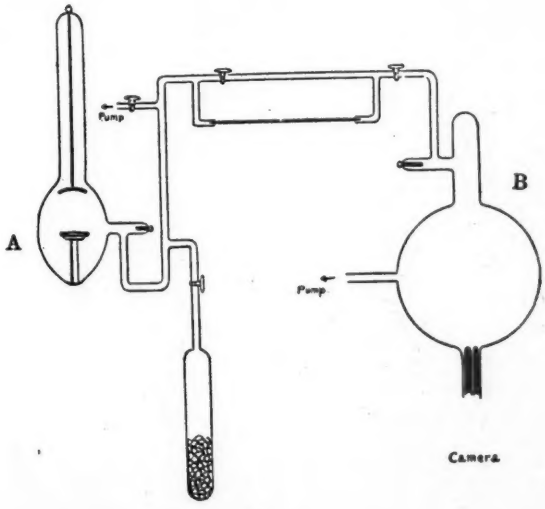


FIG. 4.

A is a vessel communicating with the bulb *B* in which the positive rays are produced by two tubes, one of which is a very fine capillary tube, while the other one is five or six millimeters in diameter; taps are inserted so that one or both of these vessels can be closed, and the vessels *A* and *B* isolated from each other. *A* is provided with a curved cathode such as are used for Röntgen ray focus tubes, and the cathode rays focus on the platform on which the substance to be bombarded is placed. [It is not absolutely necessary to focus the cathode rays in this way, but it makes the supply of the gas X_3 more copious.] After the metal or other solid to be examined has been placed on the platform, the taps between *A* and *B* being turned so as to cut off the connection between

[3] *Phil. Mag.*, XXIII., p. 192.

them, A is exhausted until the vacuum is low enough to give the cathode rays; the discharge is then sent through A, and the cathode rays bombard the solid. The result of this is that in a few seconds so much gas, mainly CO_2 and hydrogen, is driven out of it that the pressure gets too high for the cathode rays to be formed, and unless some precautions to lower the pressure were taken the bombardment would stop. To avoid this, a tube containing charcoal cooled by liquid air is connected with A, and this absorbs the CO_2 and enough of the hydrogen to keep the vacuum in the cathode ray state. To see what new gases are given off in consequence of the bombardment, a photograph is taken while the connection between A and B is cut off. After this is finished, and when the bombardment has gone on for about four hours, the tap is turned and a little of the gas from A is allowed to go into B; another photograph is taken, and those lines in the second photograph which are not in the first represent those gases which are liberated by the bombardment, and which have escaped being absorbed by the charcoal. I have here a slide (Fig. 5) representing the result of bombarding nickel. There are two

α β

FIG. 5.

photographs, one (α) before turning the tap and the other (β) after; in the second you see the three line very distinctly, while it is absent from the first, showing that the gas giving the three line has been liberated by the bombardment. I have got similar results to these when, instead of nickel, iron, copper, lead, zinc have been bombarded. I have tried two specimens of meteorites kindly lent to me from the Mineralogical Museum, Cambridge, and found there the three line. Nearly every substance I have tried gives, the first time it is bombarded, the helium line as well as this line due to X_3; if, however, the same substance is bombarded a second time, the helium line is in general absent (occasionally it is still to be detected, though exceedingly faint); and

on the third bombardment is invisible in all the substances I have tried except monazite sand, where it is given off in exceedingly large quantities as long as the bombardment continues. It is remarkable that monazite sand, which contains so many elements, gives no trace of the three line when bombarded.

I have also obtained the X_3 line and also the helium line when the tube *A* was replaced by one containing a Wehnelt cathode; with this the current of cathode rays through the tube was much larger than with the other cathode, though the velocity of the rays was smaller. The Wehnelt cathode gives the line without placing pieces of metal in the tube, so that in this case nothing is bombarded by the cathode rays but the glass walls of the tube; the strip of metal forming the cathode is, however, bombarded by the positive rays.

The three line when present at all continues even though the bombardment is very prolonged. In some cases the bombardment has been prolonged for twenty hours, and at the end of that time the line seemed almost as bright as at the beginning; indeed I could not feel certain that there was any difference. This might lead one to suspect that X_3 was manufactured from the lead or other metal by the bombardment rather than stored up in it, and this view might be regarded as receiving some support from the fact that very little of the X_3 is liberated by heating. The following experiment is an illustration of this. I took a piece of lead, and instead of bombarding it with cathode rays I placed it in a quartz tube connected with vessel *A*, and heated the tube to a bright red-heat for several hours. Large quantities of CO_3 and hydrogen were driven off by this process; this was absorbed by charcoal, and the residual gases, which had accumulated in *A*, were admitted into the vessel *B*; the X_3 line and helium line could just be detected, and that was all. I then gave the lead a second heating, raising this time the temperature until the quartz was on the point of softening. The lead was boiling vigorously; the heating was kept up for about three hours. In this time about three quarters of the lead had boiled away. I then let the gases which had been given off at the second heating into the vessel *B*, and took another photograph; no trace of the line due to X_3 or helium could be detected. The fraction of the lead which had not been boiled away was now placed in *A* and bombarded by cathode rays. It now gave the three line quite distinctly; the helium line was visible, but faint. By the bombardment with the cathode rays the lead was only just melted, so that the average temperature was much less than when it was heated in the quartz tube. This rather suggests that the X_3 might be due to a kind of dissociation of the metal by the cathode rays, and not to a liberation of a store of that substance. Another experiment shows, however, that for lead, at any rate, this view is not tenable. I took some lead which had just been deposited from a solution of lead

acetate by putting a piece of zinc into the solution, and forming the well-known lead-tree. When I bombarded this freshly precipitated lead, I could get no trace of the X_3 line; the helium line, too, was absent. I then tried another experiment. I took a piece of lead and divided it into two parts. The first of these I bombarded by the cathode rays: it gave the X_3 line quite distinctly. The other part I dissolved in boiling nitric acid, getting lead nitrate. The nitrate was heated and converted into oxide, and this was bombarded by the cathode rays: it did not give the X_3 line, showing that the X_3 is not produced by the bombardment, but is something stored up in the lead, which can be detached from it when the lead is dissolved. I have tried several samples of lead; the one which gave the X_3 line most distinctly was a piece of lead from the roof of Trinity College Chapel, several hundred years old. A sample of Kahlbaum's chemically pure lead, which must, I suppose, at no distant date have been subjected to severe ordeals by fire and water, showed the line quite distinctly, though not so well as the older lead. I have tried similar experiments with iron, and found that iron which gave the three line very distinctly ceased to do so after it had been dissolved in acid.

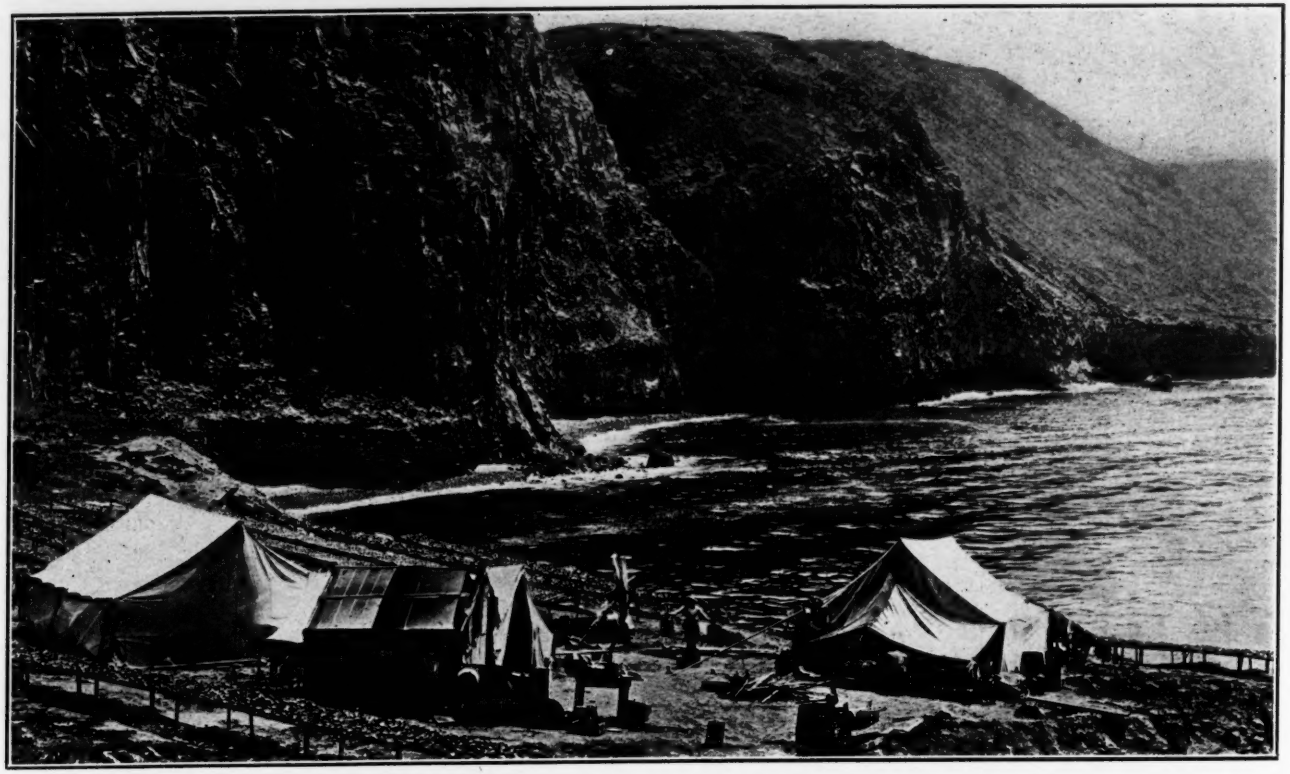
As the most obvious explanation of X_3 is that it is H_3, bearing the same relation to hydrogen that ozone does to oxygen, and produced in some way from the hydrogen dissolved in the metal, I tried if I could produce it by charging metals with large quantities of hydrogen, and then seeing if the hydrogen coming from the metal gave any traces of H_3. Thus, for example, I tested the hydrogen given off from hot palladium, but found no trace of X_3. I then charged nickel at a temperature of about 355° C. with hydrogen in the way recommended by Sabatier, but found no increase in the brightness of the X_3 over nickel that had not been deliberately exposed to hydrogen. I tried if the brightness of the line would be increased by adding hydrogen to the bulb *A*, in which the bombardment took place, but found no effect. I also tried adding oxygen to this bulb, thinking that if it was H_3 it would combine with the oxygen, and thus be eliminated, but no great diminution in the intensity was produced by this treatment. The gas seems quite stable, at least it can be kept for several days without suffering any diminution that can be detected; indeed, when once it has got into a bulb, there is considerable difficulty in getting the bulb free from it. It must be remembered, too, that by the method it is produced the gas is subjected all the time to electric discharges which would break it up unless it possesses very great stability. Thus if X_3 is a polymeric modification of hydrogen, it must possess the following properties:

1. It must be very stable.
2. It must resist the action of oxygen.

3. It must not be decomposed by long-continued exposure to the electric discharge.

These are properties which *a priori* we should hardly have expected an allotropic modification of hydrogen to possess.

Mendeleef predicted the existence of an element with an atomic weight 3. According to him this element should be intensly electronegative and possess the properties of fluorine to an exaggerated extent. The gas X_3 can, however, be kept in glass vessels, which we should not expect to be possible if it possessed more than fluorine's power of combining with glass. I prefer to defer expressing any opinion as to the actual nature of the gas until I have had the opportunity of making further experiments upon it. It is only about two months ago that I found how to get the gas with any certainty, and, as the method involves long bombardments, each experiment takes a considerable time. This has prevented me from making several experiments which suggest themselves, and which ought to be made before coming to a final decision. I thought, however, that the investigation, though incomplete, might not be unsuitable for a Friday evening discourse, as the gas, whatever its nature, is certainly one of considerable interest, and its detection illustrates the delicacy of this new method.



THE JAPANESE CAMP AT SAN CLEMENTE ISLAND.

THE ABALONES OF CALIFORNIA

By Professor CHARLES LINCOLN EDWARDS

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THE abalone belongs to a family of marine snails, the Haliotidæ, which has many representatives in the waters about Africa, India, Japan and the neighboring islands. Six species and one variety have been described from the Pacific coast of North America, but none from the Atlantic coast. Under the name of ormers, sea-ears, or ear-shells, this gastropod occurs on the coast of France and among the Channel Islands, but the species are most abundant in tropical and semi-tropical regions.

The abalone is of importance because of its beautiful shell, polished as an ornament, or manufactured into many kinds of novelties and jewelry. Gleaming with the iridescence of the rainbow and the aurora this lovely shell is fit to be the chalice of Eos. Pearls may be secreted around foreign particles accidentally, or designedly, introduced between the mantle and the nacreous layer of the shell. The mollusk *Pholadidea* may bore through the shell and cause the formation of the blister-pearl, or we may bring about the same result by inserting a prepared form. Then the meat, either fresh or dried, is of much food value.

In the commercial fishery of abalones, one or more crews are employed, generally made up of Japanese, but sometimes of Chinese or American fishermen. The boat containing a crew is either rowed, or driven by motor, from the camp to the fishing grounds. The crew consists of the diver and his six assistants. When over the right bottom the diver is clothed with his suit, the helmet screwed upon the brass collar, the heavy lead breast and back weights adjusted, and the air-pump manned. One man takes the diver's signal rope, another the hose from the air-pump, and the diver, with a net attached to a rope and his shucking-chisel in hand, is assisted over the side, climbs down the short ladder and drops through the water to the bottom. If he finds the abalones plentiful, work is continued in depths of from twenty to sixty-five feet, in four-hour shifts. The man on the boat with the signal rope in hand follows the course of the diver by the constant stream of air-bubbles rising to the surface. When the kelp is thick one man has a knife on a long pole, with which he cuts the sea-weed and keeps the air-tube clear.

The diver finds it an easy task to detach the abalone from the rock

THE DIVER GOING DOWN THE LADDER.

if he pushes the shucking-chisel under the expanded foot before the animal is alarmed. If, however, the diver hesitates and the abalone contracts its muscular foot a powerful pressure is exerted. One or two cases have been reported of the drowning of Chinese fishermen who have had their hands caught by the abalone and thus held until overcome by the rising tide. The diver secures a net full of abalones, gives the signal and the mollusks are hoisted aboard and stowed below. The net, filled with about fifty green and corrugated abalones may be hauled up every six or seven minutes. During his shift below the diver gathers from thirty to forty basketfuls, each containing one hundred pounds of meat and shell, or altogether one and one half to two tons.

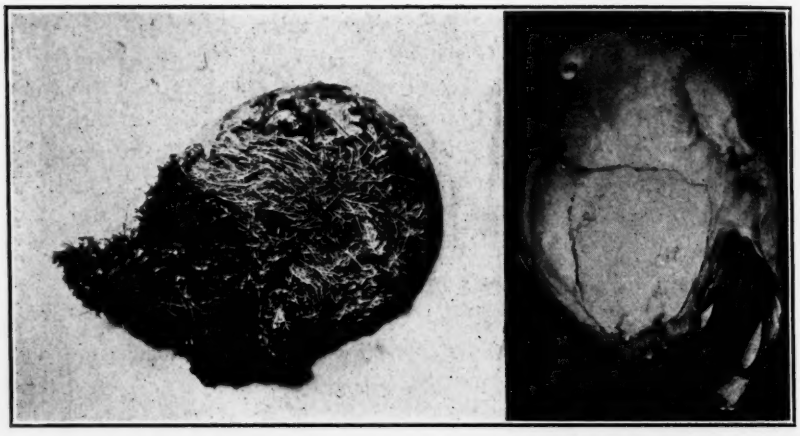
At Santa Catalina Island and later at San Clemente Island in company with a Japanese diver, I donned a diving-dress for submarine exploration. On one occasion the assistant failed to tighten the waist-belt which is designed to keep the air in the upper part of the diving-dress. The men at the pump worked with especial assiduity and as I dropped off the ladder the inflated rubber trousers turned my feet uppermost. Head down I went through sixty-five feet of water and then, not in a position for quiet reflection, remained some moments before the Japanese assistants concluded that my signals were not being made just for the fun of it. After being pulled to the surface, reversed and relieved of inferior inflation, a successful descent was made. The submarine journey is a wonderful experience. The bottom of the sea

seems made of grains of gold and silver, shimmering in the penetrating sunlight. Upon the face of a precipice, large specimens of the green and corrugated abalones rest. The shell of each is covered with a luxuriant growth of algæ, hydroids and tentacled tube-worms, which mask the creature from its enemies. All about are large fish which swim close and peer through the glass window of the helmet. An enormous sting-ray indifferently floats by. One has a fellow feeling with these unfrighted denizens of the deep in the fascination of observing their behavior under natural conditions.

In gathering abalones sometimes a crew is composed of six divers who work without suits up to a depth of twenty feet and some of them remain under water for as long as two minutes. These expert swimmers protect their eyes with glasses and wear cotton in their ears. They pry off the abalones with a shucking-chisel, often filling their arms on the way to the boat. Every two hours they return to the launch to be warmed at the fire. It takes the united efforts of these six men to equal the catch of one diver in a suit.

The abalone has a well-developed head and a powerful, adhesive, creeping foot. The shell is flattened, and the spire, which is such a prominent conical structure in most snail shells, is depressed and inconspicuous in this form. The last greatly enlarged whorl contains the body, especially characterized by the enormous columellar muscle, whose fibers run from their origin upon the muscle scar, or center of the shell, into the foot. Numerous contractile tentacles arise from the fringed epipodial fold, or ruff, around the base of the foot. The gills, alimentary system, reproductive glands, kidneys, heart and blood vessels and the pallial and visceral sections of the nervous system lie to the left of

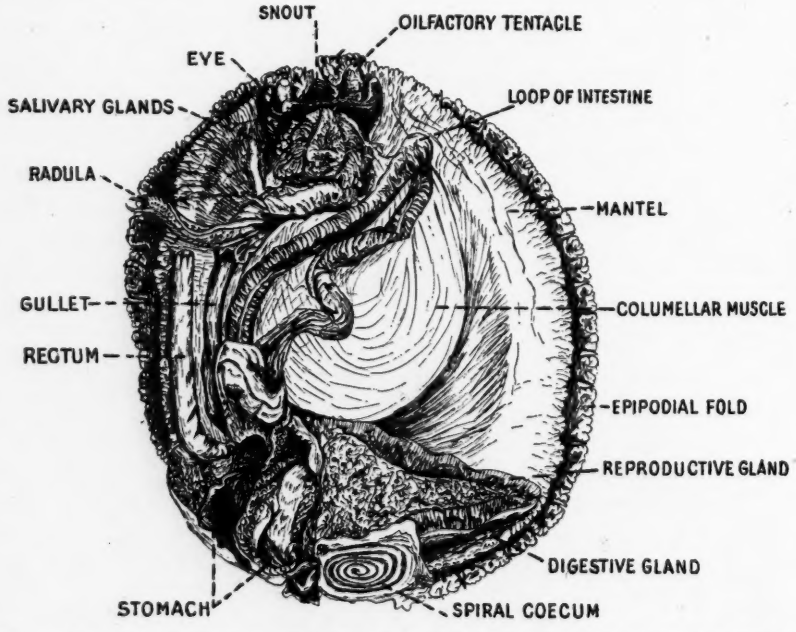
IN DIVING-DRESS READY FOR THE DESCENT.



THE GREEN ABALONE SHELL WITH MASK OF ALGÆ.

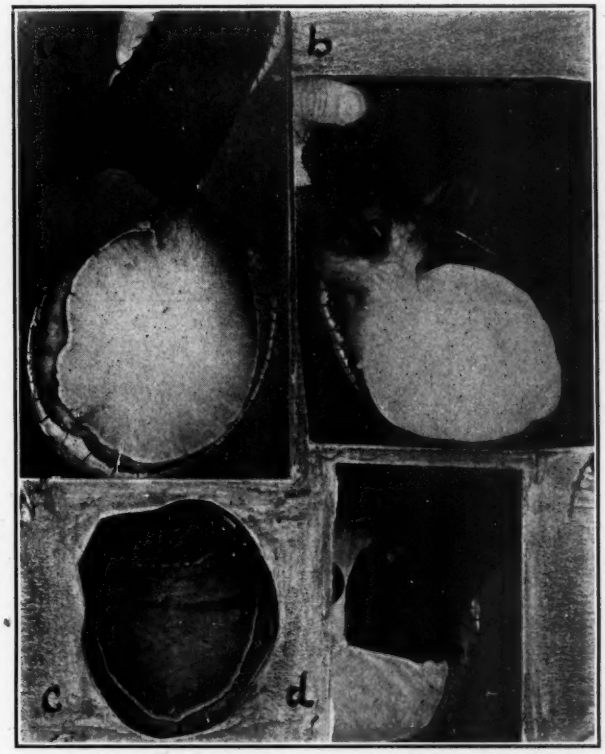
BLACK ABALONE. Shell removed, showing visceral mass terminating in the spiral cœcum posteriorly and the opened gill cavity to the left anteriorly.

and behind the columellar muscle and foot. From the mouth cavity the gullet leads backward to the enlarged stomach, which is divided into two compartments, and receives the digestive juices from the large digestive gland at the hind end of the body. Two pairs of salivary glands pour their secretions into the buccal cavity. The intestine runs



GREEN ABALONE DISSECTED. The gills, kidneys, heart and dorsal parts of mantle and columellar muscle have been removed and spiral cœcum turned over to the right.

anteriorly to the side of the head, there turns on itself and proceeds back to the stomach, where it again goes forward, passing through the ventricle of the heart, to terminate in the anus, which opens into the gill cavity. The shell is perforated, toward the left, by a series of openings lying above a slit in the mantle fold leading into the gill cavity, whence issues a stream bearing the excrement, respiratory and excretory wastes. Three tentacular processes from the edges of



FEEDING ABALONES FROM THE HAND. *a*, *b*, grasping kelp with anterior processes of foot; *c*, drawing kelp under foot; *d*, eating hole in kelp.

the mantle cleft project through these holes. As the animal grows the apertures in the shell behind the respiratory cavity are closed up and new ones are formed at the anterior edge.

The head terminates in a short snout on either side of which is a somewhat slender olfactory tentacle and slightly lateral to this a shorter and broader optic tentacle. Two elongated ganglia lying above the mouth cavity may be called the brain because they form the center for nerves from the eyes, olfactory tentacles, snout, lips and other parts of the head. The eye is a simple cup-shaped depression of the epithelium on the end of the tentacle. The cup is filled with a gelatinous lens and it has clear and pigmented retinal cells connected with fibrils from the

THE ABALONE DRYING FRAMES OF THE SAN CLEMENTE ISLAND JAPANESE CAMP.

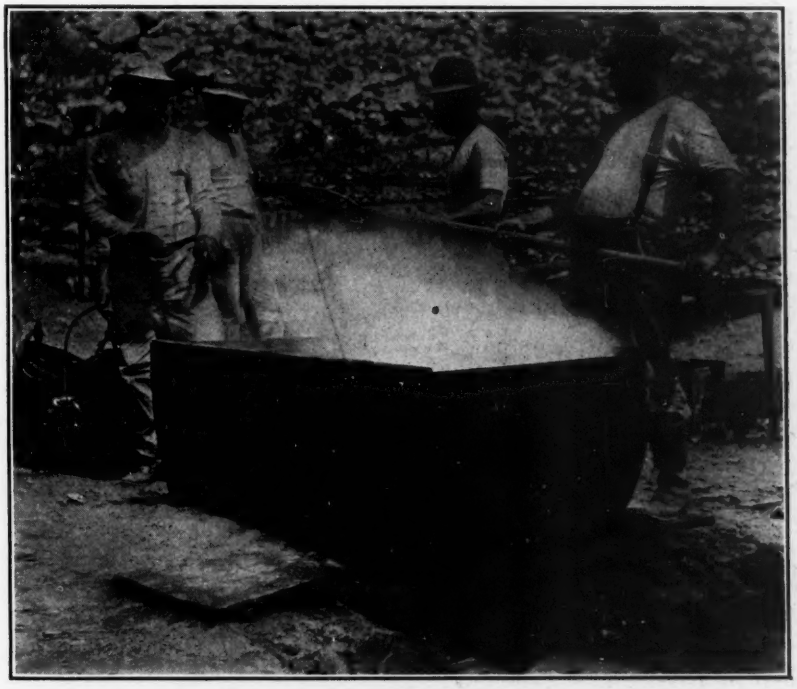
optic nerve. The shadow of a hand passing over the abalone in an aquarium causes the animal to contract the head end of the body. Hence the abalone differentiates various intensities of light and thus possesses a primitive sense of sight. The contractile tentacles running out in every direction from the ruff are end-organs of touch. Each has a nerve connected with either the right or left pedal cord. These two centers of innervation run through the middle of the foot for the greater part of its length and are connected by cross fibers. They not only recive stimuli from the sense organs of the ruff, but govern the multitude of muscle fibers which form the foot.

Scattered all over the exposed parts of the body are long spindle-shaped cells which may respond to such mechanical and chemical stimuli as to make of them indefinite end-organs of touch and smell. In the floor of the mantle cavity a water-testing sense organ, the osphradium, extends along the base of each gill. The cells of this simple end-organ are chemically stimulated in such manner that the abalone has sensations of smell, warning it to shut off the incurrent water, when foul or containing some poisonous matter.

If a piece of kelp is held motionless in front of the body, the animal soon responds by reaching out the cleft anterior portion of the foot. These finger-like processes grasp the sea-weed and pull it back beneath the mouth and foot, where it is firmly held. Cells in the mucous lining of the mouth cavity are stimulated so that the animal gets the sensation of taste. Covering the tongue is a long horny, file-like structure, the radula, with many thousands of chitinous teeth symmetrically ar-

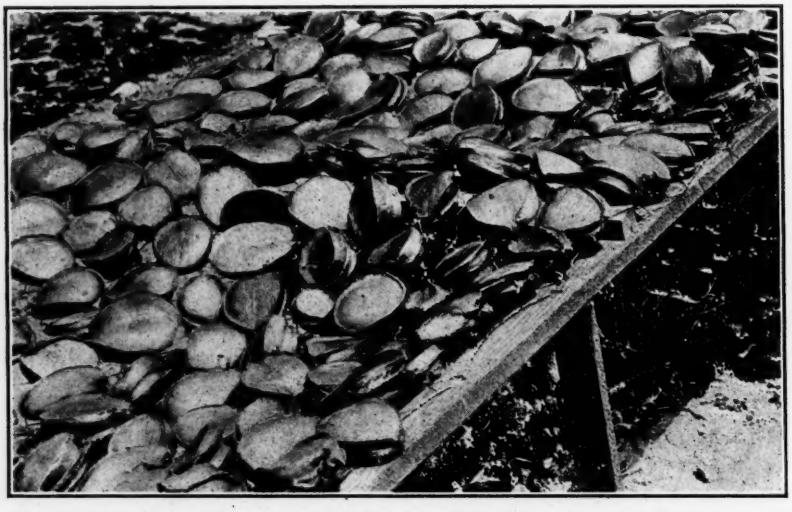
ranged in transverse and longitudinal rows. The teeth are pointed backward, and as the tongue is thrust out and drawn in, the radula rasps a hole in the succulent kelp, carrying the fragments of food to the opening of the gullet. Two chitinous jaws, one at either side within the mouth, but united in the midline, serve as scrapers to hold back in the mouth cavity the particles of food adhering to the radula. This method of feeding abalones individually by hand is of importance in easily caring for the animals in confinement in aquaria or in enclosed pools, or live-boxes in marine farming.

As food the abalone is one of the best of our marine mollusks. Detached from the shell, the visceral mass and mantle fringe are trimmed off from the large central muscle, which is then cut transversely into slices. These small steaks, when beaten four or five times with the flat side of a meat-cleaver and then fried in butter, are tender and delicious. The meat is also equally delectable when served as a chowder or minced. Besides supplying the local market the mollusks may be shipped across the continent, for when individuals are placed one on top of the other, in a sort of a living nest, they will survive for as long as six days without water, feeding upon the organisms and organic slime covering the shells upon which they rest. While the American market is not sufficiently developed to create an active demand



DIPPING ABALONES FROM THE BOILING TANK.

for fresh abalones yet in a dried state many are shipped to China. After being gathered from the rocks by the diver and taken into camp, the shells are removed and the abalones thrown into vats of salt water and left for two or three days. In this manner, the pigmented mantle fringe is removed and the meat preserved. The abalones are next washed in large tubs by means of wooden paddles and then cooked for one half hour in water almost at the boiling temperature not only for sterilization, but to give the meat the desired rounded shape. With dip-nets the Japanese workmen remove the abalones to baskets and

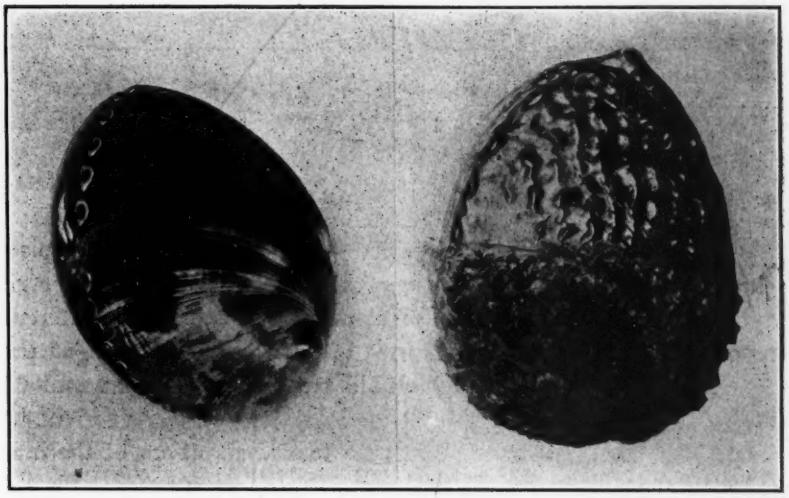


MEAT OF THE GREEN ABALONE DRYING IN THE SUNSHINE AT SAN CLEMENTE ISLAND.

carry them to the drying frames, where they are laid out in trays in the sunshine. After four or five days, or longer, if the temperature falls, the partly dried abalones are cooked in water for the second time for one hour. Next they are smoked in charcoal smoke for from twelve to twenty-four hours, and then for the third time placed in boiling water mainly for rinsing. Now they are dried for a period of six weeks and after a final cleansing bath in luke-warm water made ready for shipment. During the process of drying the meat loses nine tenths of its original weight. While hard and tough, like dried beef, it may be sliced with a sharp knife and eaten with relish. When dried the meat brings from twelve to fourteen cents a pound for the green and corrugated species, and from eight to ten cents for the black abalone. Most of the dried abalone goes to China and there finally, at retail, brings seventy-five cents per pound. A camp of fourteen Japanese fishermen brings in thirty tons, or more, of the fresh abalone in a month. There is considerable business in canning abalone for the California markets as well as for New York and Honolulu. The abalone of Japan,

the awabi, is a smaller species and the holes of the shell are relatively large, so that only the central part is of value, chiefly for use in inlaying. Gathering abalones is especially carried on by women divers, who swim out to the fishing grounds and work in depths of from six to eight fathoms. Pearls are not often found, but the meat is dried and sold as dark red disks strung on sticks.

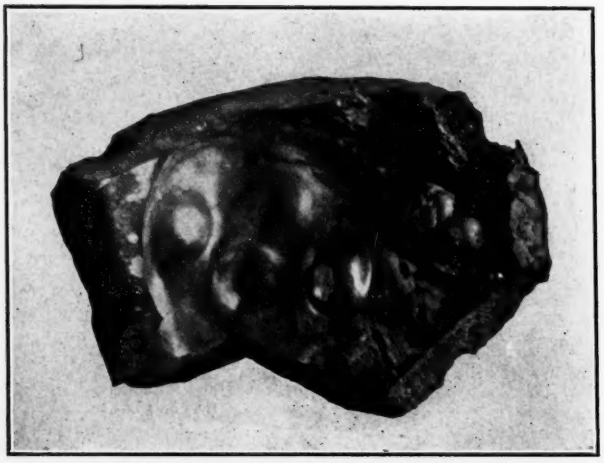
The familiar polished abalone shells have gone all over the world and everywhere are highly esteemed as ornaments. The shell is polished by grinding it first on a carborundum wheel until the desired colors are reached. The shell is then surfaced by a wheel of felt sprinkled with carborundum dust glued to the wheel. Finally it is



POLISHED BLACK ABALONE SHELL. SHELL OF THE CORRUGATED ABALONE. The unpolished posterior half showing incrusting worm tubes.

polished with a wheel made of many layers of cotton on the edges of which tripoli has been rubbed. This wheel is revolved about twenty-two hundred times per minute. The quality of being easy, or hard, to grind and polish is spoken of by the manufacturers as the texture of the shell.

The shells are sorted into two classes, but ordinarily classes one and two are mixed together. At Avalon, in 1870, when the meat sold for five cents a pound, the green shells brought eighty dollars a ton. At the present time the green shells are sold at one hundred and twenty-five to one hundred and eighty dollars a ton, the black, at eighty to one hundred dollars a ton, and the red, at forty to seventy-five dollars a ton. The black shells, with especially good pearly centers, bring from three hundred to five hundred dollars a ton. Owing to the increasing scarcity



A Portion of the Red Abalone Shell with Four Blister-pearls and Two Free Pearls.

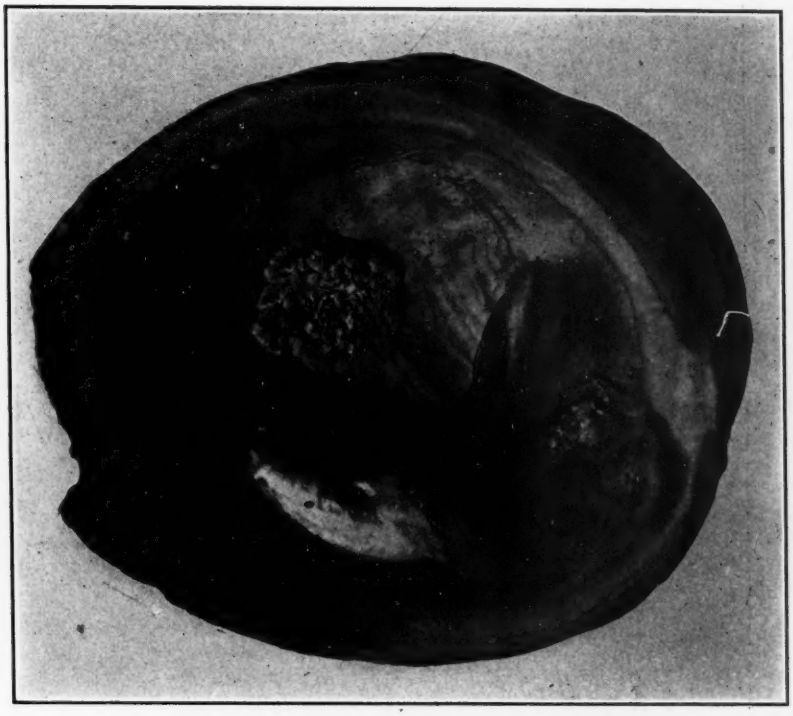
of good green shells, there is a growing tendency to use the centers of the red shells for jewelry.

When the shells are cut into ornaments, as many as fifteen pieces, including one scimitar-shaped paper-knife made from the lip, or rim, may be produced from one shell of about twenty-two inches in circumference. At an average retail price of fifty cents for each of these pieces the products of the shell would realize seven dollars and fifty cents.

The blister-pearls are more or less extended elevations of the inner,

Shell of Red Abalone Opened to show a Razor-clam Shell Forming a Blister-pearl Nucleus.

pearly layer of the shell, formed by the secreting cells of the mantle in defense of the invading, boring mollusk, *Pholadidea parva.* They occur mostly in the red abalone, with only one blister-pearl in about a thousand shells of the green or black species. A crab, which infests the abalone at certain seasons, may be the cause of such formations, and one exhibited the complete outline of such a crab. Frequently the blister-pearls are formed over sea-urchin spines, chiton or razor-clam shells,

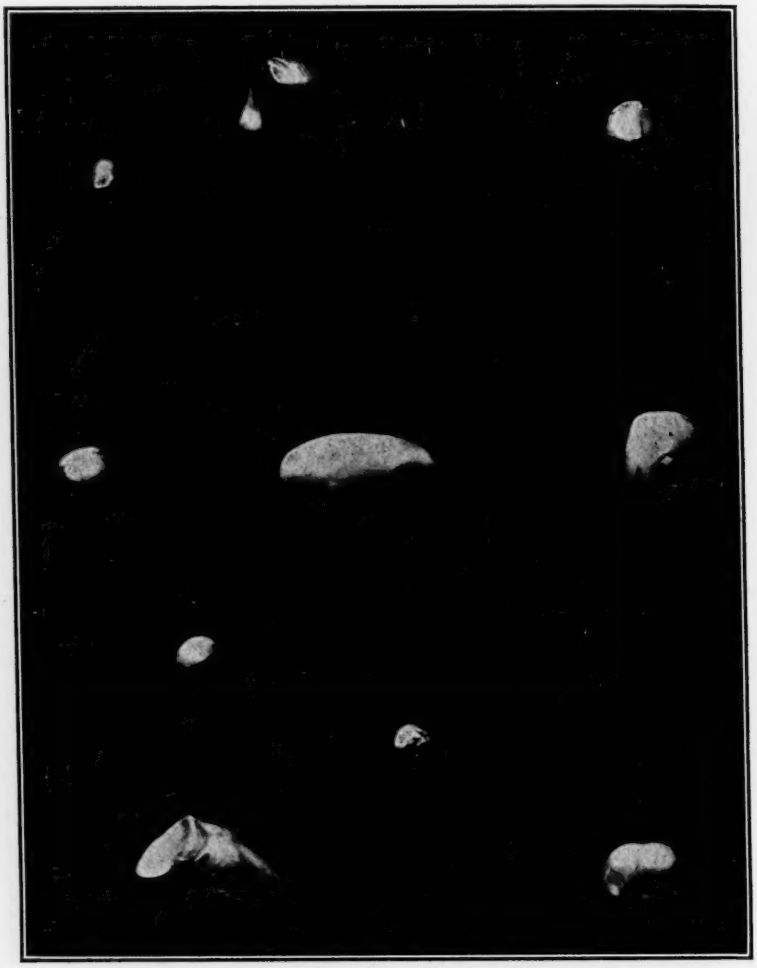


BLISTER-PEARL FORMED OVER A DISEASED VISCERAL HUMP.

pebbles and other foreign bodies retained beneath the mantle. Sometimes a diseased visceral hump is cut off and covered by nacre, making a huge blister-pearl.

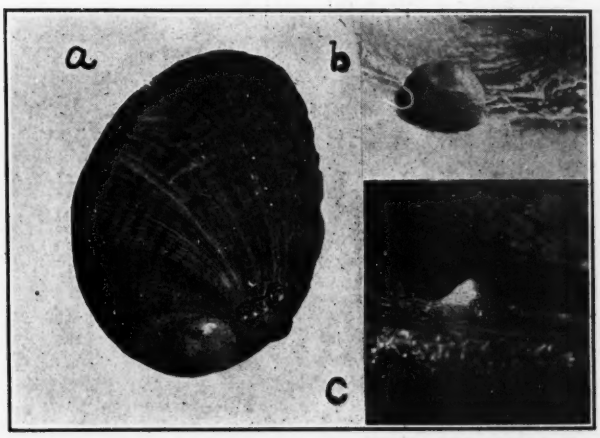
The free pearls have the color of the inside layer of the shell, varying from white, to green, or pink, according to the species. They sell from fifty cents, for the smaller ones, to one hundred and twenty-five dollars for one of twenty-five grains. Occasional pearls are so large and of such fine quality as to sell for five hundred, or even one thousand dollars. The free pearls are frequently found within the stomach. During the year 1912, over eighty-six thousand blister pearls and four thousand free pearls have been obtained from the abalone fishermen.

The origin of pearls has been a matter for speculation during many



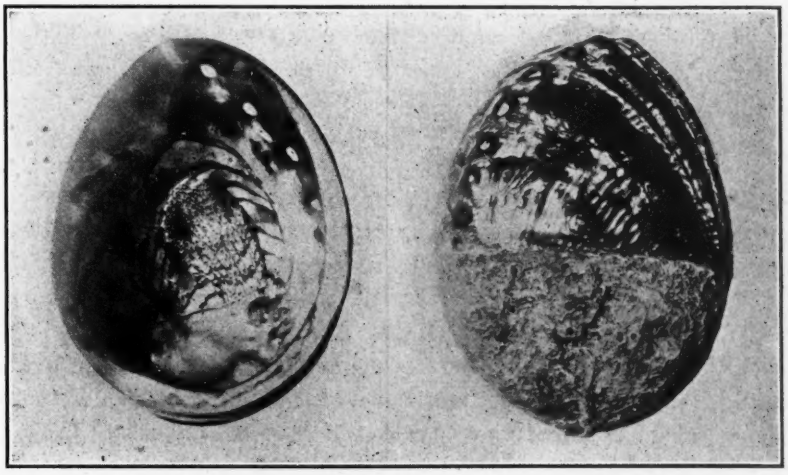
FREE PEARLS FROM THE ABALONE. The central pearl large and valuable. From the collection of C. B. Linton.

centuries. As related in ancient folk-lore, the pearl-oyster, rising to the surface of the sea in the early morning, opens wide the valves of its shell, so that dew-drops may fall within. Under the influence of the air and warm sunshine lustrous pearls develop from these glistening drops of dew. The pearls are white when the weather is fair, but dark if it is cloudy. This belief was held from the first to the fifteenth centuries, when the theory was advanced that the eggs of the pearl-oyster serve as nuclei for pearls. About the middle of the sixteenth century Rondelet concluded that pearls form from diseased concretions, and then, in 1600, Anselmus de Boot demonstrated that they are made of the same substance as the shell. Réaumur, in 1717, showed by aid of the microscope that the pearl is composed of concentric layers of



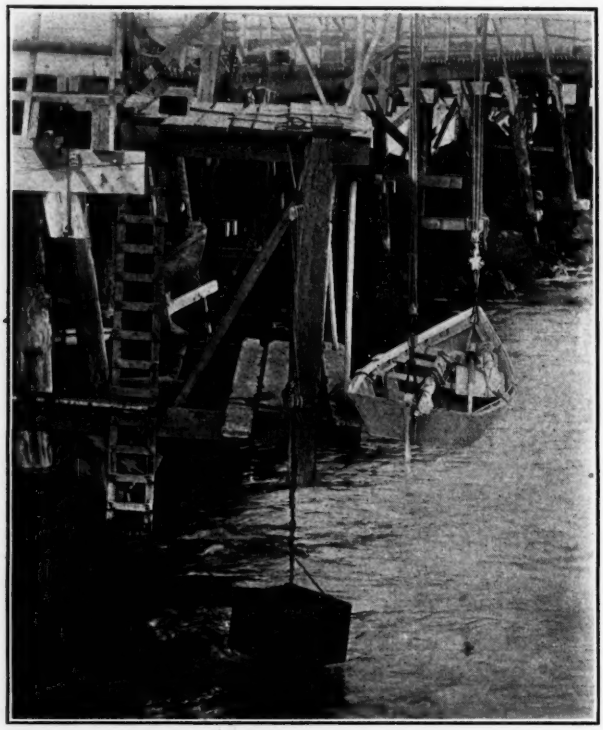
(*a*) Black abalone shell with pearl form inserted. (*b*) Head of shell pearl form on inner side of black abalone shell. (*c*) culture pearl formed in the green abalone in seven months.

nacre which we now know serve as minute prisms to split up the white light into the rainbow tints so beautiful when reflected from the surface of the pearl. In the middle of the nineteenth century from an investigation of the fresh-water mussels of Turin Lake, Filippe proved that the stimulus for pearl formation in that species is a trematode worm. Other naturalists, Küchenmeister, 1856, Möbius, 1857, Kelaart and Humbert, 1859, Garner, 1871, Dubois, 1901, and Giard, 1903, have contributed to our knowledge of the origin of pearls from parasitic nuclei. In 1902, Jameson traced the life history of a *Distomum* from its first host, a duck, to a clam as its second host, and he succeeded in



INTERIOR VIEW OF THE RED ABALONE SHELL, showing pearly center within the muscle scar.

SHELL OF THE GREEN ABALONE. The anterior portion polished.



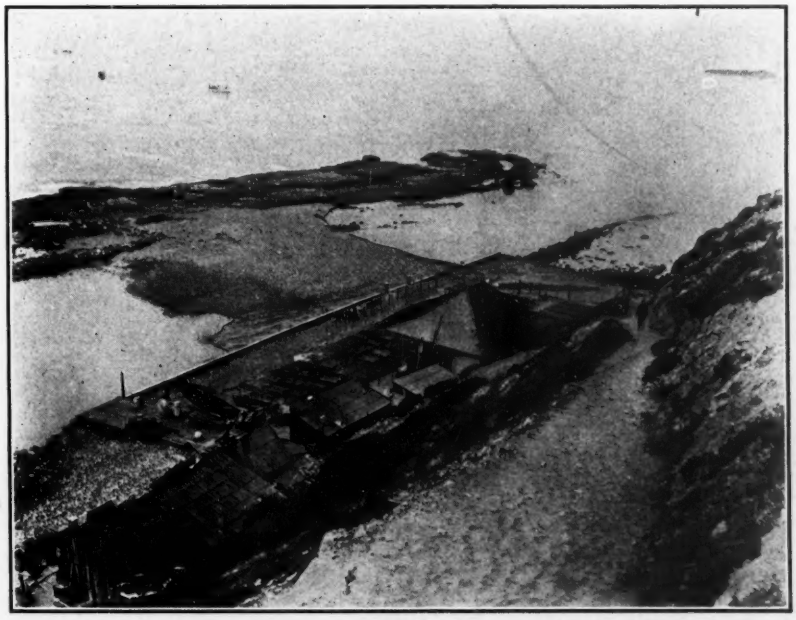
THE CONCRETE LIVE-BOX ABOVE WATER AT LOW TIDE.

inoculating the edible mussel, *Mytilus,* by placing it with parasitically infected mollusks and thus artificially induced the formation of pearls. Herdman, in 1903, found in the pearl-oysters of Ceylon that a tape-worm larval cyst may become a pearl nucleus, or that in some cases the secretions may be deposited around sand grains, bits of mud or a fish or some other small animal, in pockets of the mantle epidermis, or again about calco-spherules near the muscle insertions. The surface finally becomes polished, or takes the "orient," and thus reflects the opaline and nacreous tints so highly prized.

The production of culture pearls dates back to the fourteenth century in China and it is probable that the Arabs had a similar industry. The Chinese open the shell of the river-mussel, push back the mantle and introduce metal images of Buddah which are covered with nacre in the course of six months. Linné drilled a hole through the shell and inserted a pellet of limestone on the end of a silver wire so that the nucleus might be kept free from the shell during the secretion of nacre. In more recent times the secretion of culture pearls has been induced in pearl-oysters by similar methods in various countries. Bouton, in 1897, at Roscoff, France, bored small holes through the shell of the abalone and inserted forms made of mother-of-pearl. After

some months beautiful pearls were secreted, their size being in proportion to the length of time of the culture.

In our red abalone a boring mollusk, *Pholadidea,* penetrates the shell from the outside. It files its way, by means of sharp teeth on its shell and possibly by the secretion of sulphuric acid. The burrow enlarges, as the *Pholadidea,* growing in size, digs its way in. When near the inner pearly layer of the abalone shell, the host resists the oncoming *Pholadidea* by secreting more nacreous matter. Thus the defensive wall, eaten by the *Pholadidea,* grows inwardly as a mound-shaped projection, the blister-pearl. In imitation of this natural process, a hole is drilled through the abalone shell and a form is inserted. This form, made of shell, is shaped like a long-shanked collar-button and so placed that the expanded curved base lies against the pearl-secreting mantle. The shank projects from the outer surface of the abalone shell and is there made fast by aluminum wire, to which a metal tag, bearing the serial number, is attached. In some cases the wire has corroded, with the loss of the tag. In later experiments the numbers have been filed upon the shell. The black abalone has been used in most cases, although a few experiments have been made upon the green abalone. Holes have been drilled through various parts of the shell and different numbers of forms inserted. In addition, spherical forms, without shanks, have been placed beyond the mantle cavity near the visceral hump. I have succeeded in raising abalone culture



THE JAPANESE ABALONE CAMP AT WHITE'S POINT, CALIFORNIA.

pearls in one hundred and thirty-three days. These pearls, however, are thin layers of nacre, formed over a horny basis, which is the first material to be secreted. In the natural process of continued deposition they increase in thickness and solidity and consequently in value. One produced in a green abalone in seven months shows good form and luster. My average time for drilling a hole in the abalone shell, inserting the form and wiring it in place with the numbered metal tag, is eight minutes. This working time might be decreased by an expert laborer doing nothing else, so that the business of raising pearls would be of interest and profit. Mr. C. B. Linton has succeeded in producing similar culture pearls by drilling a hole through the shell center, pushing in a round ball, made from shell, and filling the outside end of the hole with beeswax and cement.

Based upon the fact that each ton of abalone shells represents a certain value of manufactured jewelry and novelties, it is possible to estimate the value of the abalone industry. Shells of the black abalone are sorted into two classes. Each ton of those with fine, pearly centers will make novelties and jewelry worth, at retail, four thousand dollars. The class known as button shells, with plain mother-of-pearl surface, represents a final value of one thousand dollars and the shells of the green abalone, three thousand dollars. For the fiscal year ending in July, 1912, the following shipments were made from Long Beach and represent the given valuations in manufactured products: thirteen tons of pearl center black abalone shells, fifty-three thousand dollars; forty tons of button black abalone shells, forty thousand dollars; fourteen tons of dried abalone meats at two hundred dollars a ton, twenty-eight hundred dollars; a total of ninety-five thousand eight hundred dollars. The shipping statistics are not complete for the other California ports, but it is demonstrable that the abalone industry may be developed into one of great value.

Much has been said recently in the newspapers concerning the threatened extermination of the abalone. That this is a real danger, and not an idle theory, is apparent to any one familiar with the facts. For instance, near Avalon, Santa Catalina Island, not more than twenty years ago, the green and corrugated abalones were so thick that they rested upon one another four or five deep, all over the rocks. After much searching in this locality during the last year I was unable to find a single specimen. The shells brought up by the divers of the glass-bottomed boats, and eagerly bought by the tourists, have been placed in position previously by the enterprising management. Great shell heaps on San Clemente, San Nicholas and other islands prove the abundance of abalones during the centuries of Indian occupation. Some of the red shells found are unusually large, measuring from twenty to thirty inches in circumference. Necklaces of large abalone

pearls have been found with the remains of Indians. If only well preserved, some of these pearls at present would be worth as much as five hundred dollars.

In many places where the abalone was formerly abundant, the large individuals of legal size are taken and it may be true, as in the case of the American lobster, that in this manner the most prolific breeders are sacrificed. We do not yet know anything about the breeding habits and embryology of any species of abalone, and hence are not certain as to the best months for a closed season. In time, without doubt, we shall be able to artificially propagate the abalone, as has been done with the oysters, clams, lobsters and other useful animals. The government breakwater, at the mouth of Los Angeles harbor, at San Pedro, has become a natural breeding ground for black abalones which creep back under the great stone blocks and thus escape the gatherers, who are stripping every accessible niche and cranny along the coast at each low tide during the open season.

Reservations have been established at Monterey Bay and Venice, but the present laws are inadequate for their best development. By act of the city trustees, the Venice breakwater has been made a biological reservation under the control of the marine biological station of the University of Southern California and guarded by a deputy of the State Fish and Game Commission. As an aquacultural experiment I have placed colonies of several hundred black abalones and seventy-five of the green species upon the submerged rocks. A large concrete live-box has been suspended by a block and tackle hoisting apparatus at about the mid height of the tide. The open top is covered by heavy galvanized iron meshwork, while through several holes in the botton the dirt is cleaned out by the flow of the tide. The box is so heavy that one may stand upon any part of it and do the necessary work in feeding and observing the animals within. Forty abalones under experimentation and for growth records are kept in the live-box and a group of two or three times that number might easily be maintained in good condition. Near Venice the ocean is shallow, for it is three miles out to the sixteen-fathom line. The trawling of our motor-sloop, the *Anton Dohrn,* has demonstrated that in most places the fauna of the sandy bottom is poor. Better results may be looked for when reservations are located on the rocky coast, where great beds of kelp thrive just within the deep-water line. The kelp is not only important as food for abalones, but within its wide spreading fronds a world of living things thrive. In such a region the plankton is richer and these microscopic plants and animals generate food for the larger swimming and bottom-dwelling forms.

The establishment of laws for the regulation of aquaculture and the concomitant protection of marine and fresh-water organisms is of

primary importance. The formation of reservation districts for absolute closure during successive periods of years, within which we may have, every five or ten miles, smaller perpetual biological reservations for breeding centers, will solve the problems of preservation in a better manner than the present laws for closed and open seasons. In Germany the Elster River pearl mussel beds and in France the marine mussel and oyster fisheries have been saved and developed by proper legislation and governmental supervision. In this country the business of oyster propagation and farming has been profitably established under such well-developed laws as those of Connecticut. It would be difficult to attempt an estimate of the remarkable achievement of the Bureau of Fisheries in the field of aquaculture. The shad, the salmon and now the fur-seal have been saved from extermination. So abalones may be raised in the sea as easily as chickens upon the land. The coastal waters must be surveyed for leasing by the state and then a police force organized to guard the marine farms from all the poaching pirates. It can not be emphasized too often that in direct ratio with the increase of population the neglected food resources of land and sea must be conserved and developed. The company manufacturing rubber and fertilizer and extracting iodine from kelp should only be allowed to cut the seaweed under such restrictions as will preserve the natural home and food supply of all the countless dependent organisms. The inherent tendency of man to rob the earth and sea in order to promote his own selfish interests must be restrained for the larger benefit of his fellows and the salvation of his descendants from want. The sea is the last great field for human exploration and exploitation. We know so little of its vast resources that we can scarcely dream of the possible future industries which will arise under a wisely administered system of aquaculture.

THE PRESIDENT OF THE NINTH INTERNATIONAL CONGRESS OF APPLIED CHEMISTRY

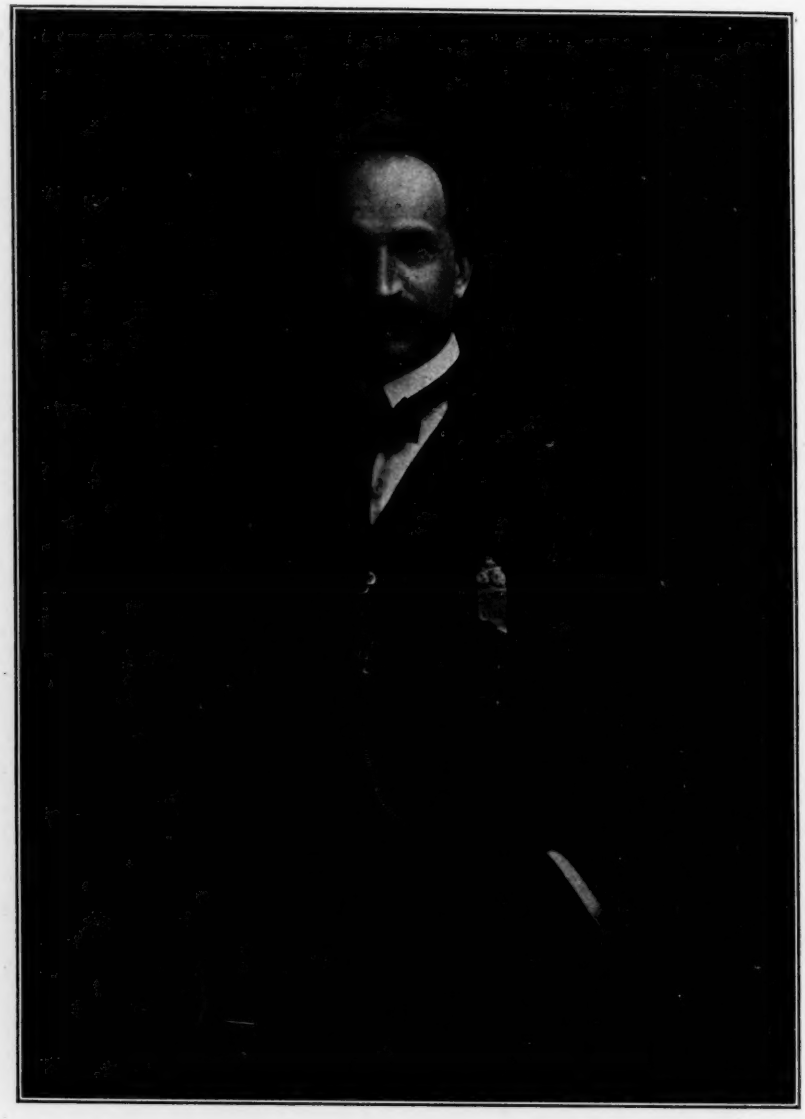
By Dr. GEORGE FREDERICK KUNZ

NEW YORK CITY

THE newly elected president of the Ninth International Congress of Applied Chemistry, Professor Paul Walden, was born near Riga in the Russian province Livonia July 27, 1863. Hence, although of German blood, he is by birth a Russian. He first attended the Real School in Riga, and then the Polytechnicum there, where he was one of the most apt and brilliant pupils of the great Ostwald. In Riga, he was assistant in the department of physics in 1885, and in 1888 in that of chemistry; in 1892 he became Privat-docent, and in 1894 professor of analytical and physical chemistry. Since 1896 he is assistant professor of inorganic and physical chemistry, and at the same time director of the Polytechnicum.

When Ostwald resigned his professorship of chemistry at the Polytechnicum, Walden became his successor, and the latter still holds this position at the present time. He received his degree of doctor of philosophy at Leipzig in 1891, that of master of chemistry at Odessa in 1893, that of doctor of chemistry at St. Petersburg in 1899 and that of doctor of engineering at Riga. The remarkable work performed by Professor Walden has been officially recognized by the bestowal of many important Russian orders; he is a commander of the Order of Vladimir and also of those of St. Anne and of Stanislaus. He is a member of the Russian Academy of Sciences at St. Petersburg, and has laboratories both in Riga and in St. Petersburg. He is an honorary member of the London Chemical Society and of many other societies, and was selected as the Imperial Russian delegate to the Eighth International Congress of Applied Chemistry.

Professor Walden speaks Russian, Livonian, French and German fluently, and is familiar with English and Italian as well. In manner he is quiet, dignified and gentle, but alert and quick in his movements. He is about five feet eight inches in height and weighs some 175 pounds. His brown hair is brushed high on his forehead; he has light blue-gray eyes and fine teeth. He is a very fluent and ready speaker, and his delivery is at once easy and impressive. Always speaking directly to the point, his words are so well chosen and effective that invariably he holds the attention of his audience; there never can be any doubt as



PROFESSOR PAUL WALDEN.

to his meaning. The directness of his thought finds corresponding expression in his words and they carry conviction to the minds of his hearers, while his kindly smile serves to enlist their sympathies and approval.

His greatest work has been in stereochemistry. His work on the atomic transformation, the theory of solutions and other great problems is now classic. His literary activity has covered a wide field and he is the author of more than two hundred original scientific articles or books, nearly all on the subject of chemistry: physical chemistry, biochemistry and stereochemistry. For many years past his contributions to periodical publications such as the *Berichte der deutschen chemischen Gesellschaft,* Ostwald's *Zeitschrift für physicalische Chemie,* Lorenz's *Zeitschrift für anorganische Chemie,* etc., have been of the very highest value to science.

The biographical memoirs he has written of the eminent French chemist Berthelot, whose name is indissolubly associated with the science of thermochemistry, of the great Pasteur and of the celebrated propounder of the periodic law, the renowned Russian chemist Mendeleef, testify eloquently to Walden's intimate knowledge of the life and work of these great leaders of modern science.

Together with Carl Adam Bischoff, Professor Walden published his monumental work, the "Handbuch der Stereochemie," ably treating of this intricate and fascinating department of science. On the twenty-fifth anniversary of the doctorate of Professor Ostwald, whose most brilliant and successful pupil he is, Walden issued his excellent biographical sketch of that great physical chemist and philosopher, and, we may add, enthusiastic Esperantist. Ostwald has said that he owes fifty per cent. of his reputation to Walden's biography. At this time Ostwald was appointed a director of the Polytechnicum, an honor enjoyed only by himself and three others, namely, Aristes, Arrhenius and Teppler.

Besides his original work, Walden has translated into the Russian language Fischer's "Organic Preparations," and also the renowned Lowell lectures by J. H. van't Hoff, delivered in Boston.

Russians are the best hosts in the world. Whereas, in the United States the expenses of the congress were born by the American committee and their friends, in Russia, where the railroads are owned by the government, during the late International Geological Congress the freedom of the railroads was offered to the visiting guests.

St. Petersburg, a magnificent city with its great museums, universities, art galleries and other institutions, will be a splendid meeting place, and the excursions that can be made from it will prove of the greatest interest and value to the visiting guests.

In accepting the office of President of the Ninth International Congress of Applied Chemistry, Professor Walden made the following remarks:

The choice which has just fallen upon me is a distinction of an altogether exceptional kind, and also a task of an exceptional kind. On behalf of Professor Konovaloff, who is absent, and who will assuredly regret his inability to take part in our common celebration, I can only express to you his thanks and his undoubted acceptance. In my own case, however, I realize mixed emotions. I say to myself: "Much honor, much work; many disappointments, many gray hairs!" In accepting this choice, we are fully aware that our powers will prove insufficient to do full justice to the duties entailed, but we see therein an honor rendered to our fatherland and to the great men, the great chemists of our country. I need only recall to your minds a few names; that of Lemonossoff, who one hundred and sixty years ago laid the foundation of modern chemistry; that of Grotthus, a Russian chemist of a century ago; that of Hessen, also a chemist, and finally I name to you our great fellow-countryman, recently deceased, Mendeleef, the creator of the periodic system of the elements. I assume that the honor you have just accorded to our fatherland is also addressed to these great men. We are the inheritors of the deeds these men accomplished. It is not the mind alone that rules congresses, the heart also must have its say. Of the scope of my mind, I am, naturally, not qualified to speak, but in what concerns my heart, in what concerns my ardent wish to do my best, to give you the best possible reception, as to this I believe I can safely speak, as to this I shall willingly and gladly compete with the gentlemen who have received us in former congresses, and if three years hence, in transmitting my office into other hands, I may perhaps be able to speak in my turn with the sunny humor of our president of to-day, then I shall be content. I thank you.

As the leader, director and presiding officer of the Ninth Congress of Applied Chemistry, Professor Walden possesses many notable qualities which must aid in rendering that congress a success. With its complex composition, made up as it is of as many, or perhaps more countries than there are known chemical elements, we might say that no one was better qualified than Professor Walden, with his intimate knowledge of the art of combining and ordering the various chemical elements, and we have no doubt that he will be equally successful with the various and eminently individual human equations in the congress, and that they will be so welded as to constitute a thoroughly homogeneous assembly, which will be brought to a close in a manner satisfactory to all, after the members shall have given free and full expression to their views.

The eighth congress had to decide whether four or but three official languages should be recognized, and the action finally taken favored the recognition of four—English, French, German and Italian. At the ninth congress many interesting matters will have to be discussed and determined; one of the most important contemplates the securing of an agreement among scientists to accept a standard determination of atomic weights by successive congresses, the weights recognized as au-

thoritative by any one congress to be regarded as such until changed by a succeeding congress. By this means a general rule would be established which would govern the use of atomic weights both industrially and scientifically. The eighth international congress strongly advocated and recommended the adoption of standard governmental examination of ores, metals and fuels. This is highly important for the avoidance, or at least for the decision, of disputes as to the relative richness of the various deposits, and also for the proper and consistent utilization of national resources in such materials.

For the ninth congress will remain the question as to the proper placing of the international delegates. Then the proper assignment of the papers to be read is to be considered, so as to determine and define the priority of one nation over another in regard to recent scientific or industrial discoveries in any one of the hundred or more special fields of experiment and research so ably exploited by the industrial giants who make up a congress such as the eighth International Congress of Applied Chemistry, which has just closed with absolute harmony. This was due in great measure to the splendid leadership of the retired president, Dr. William H. Nichols, who was the cornerstone as well as the central figure of this congress, and who with remarkable tact and ability steered the ship of this great congress safely into the port of the ninth international congress.

The following is a list of all the International Congresses of Applied Chemistry:

No. of Congress	Date	Place
First	1894	Brussels
Second	1896	Paris
Third	1898	Vienna
Fourth	1900	Paris
Fifth	1903	Berlin
Sixth	1906	Rome
Seventh	1909	London
Eighth	1912	New York City
Ninth	1915	St. Petersburg

[1] For a further discussion of the chemical and other international congresses, see "International Congresses," by Dr. Charles Baskerville, *Science*, N. S., Vol. XXXII., No. 828, pp. 652–659, November 11, 1910.

THE AMERICAN COLLEGE, AS IT LOOKS FROM THE INSIDE

By Professor CHARLES HART HANDSCHIN
MIAMI UNIVERSITY

THE future of higher education in America depends upon the position we shall grant to the college and university professor. The growing conception that the faculty—not buildings, nor advertisements, nor pyrotechnic display—but the faculty, makes the school is bound eventually to be accepted.

But before a faculty can make a school, it must be a real *collegium*, a corporation of teachers, besides whom everything and every one in the school is insignificant, their wards excepted, who, however, are *wards*.

On the other hand, it is all very well for professors to talk about being the big part of the show, bigger than the students, the equipment and the administration. We believe they should be, but we do not believe they should be, unless they are. A weak faculty can not direct the course of a school nor wisely elect additional members to their own body.

To qualify to do this, there must be, first, thorough scholarship—not $800 to $2,000-a-year scholarship, but $2,500 to $5,000-a-year learning. A mercenary view, you say. Granted. But it is the only one that has any weight with the majority of your good constituency. In our day a professor, as well as any other man, is respected according to the salary he can command. Gainsay it who can.

But you say, "Where does the college professor's idealism come in?" Why, it doesn't come in; it's gone, and you drove it out of the back door. You have respected him as he has been able to have a fine house, and all talk of his working for the love of learning—and poverty—is fol-de-rol. $2,500 to $5,000-a-year scholarship it must be, or be held in disdain by the butcher, the baker and the candlestick-maker, and any one else who can "sport" a "machine" and dress his women folk in the latest creations.

But beyond scholarship the faculty needs a sense of dignity as a body. Professors, as a rule, nowadays, are not overburdened with personal dignity. In our democratic rage to level all classes downward, we have levelled the college professor from his one-time dignified manner and station to the *niveau* of the untrained and unfinished student and the unmannered and illiterate townsman. Your professor slaps his darky laborer on the back with the manner of a pal, he addresses his students as "fellows," he puts his feet upon the table in his class-

room, he howls and even cusses on the foot-ball field—and if he does not do these things, you and your callow sons will rise up to boycott him and dub him "uppish."

But if professors are not overburdened with personal dignity, the sense of dignity and the right to be respected and heard as a body in the faculty is positively wanting. This is true not only in a few schools, but, almost without exception, in all. The trouble, as indicated, lies as much with the professors themselves as with others. Faculties have failed to demand respect for their views and findings. The average faculty does not respect its own decrees. As Americans, I assume, our respect for law may be taken to be *nil,* but the intelligence of the all-wise faculty should dictate some respect at least for their own laws. But they have none. Oh, there are a few schools which have codified the rulings passed from time to time by the faculty, but in the great majority of cases no one in the school knows anything about past legislation. It might be found, possibly, by running through the faculty minutes of the past years, but who would be so foolish as to do that when it is so easy simply to "knock off" a new law whenever the need arises, and thus make the law *von Fall zu Fall,* as Bismarck made politics.

What the college "senate," as we sometimes proudly call the faculty, needs is a sense of dignity as a body, after the fashion of the original "senate" which wrote its own name first in the proud phrase *Senatus Populusque Romanus.* Far be it from the American college senate to write its name ahead of anything! This is the style it employs: *The Students, Administration, the Janitors and the Senate of So and So.* Most faculty men are too jealous of each other and of their "stand in" with the administration ever to pull together in anything that makes for strength in the faculty. Then there are, of course, the invertebrates and the weak whom ye have with ye alway; but that brings me to another chapter.

It is the chapter entitled: Scholarship not wanted in America! There are various reasons for this ukase which has gone forth. First, men of real scholarship might some time take it into their heads really to make the sons of fond parents study. Such old-fashioned notions would mean calamity—calamity to culture, because to get culture you must do nothing for at least four years. As the average small college has it: a four-years' loaf makes a well-bred man. Calamity to education for citizenship, for education for citizenship, as the cry is now penetrating to the small college, means, I fear: athletics, social intercourse, random talks by lawyers, politicians; a lot of frothy stuff about the glory and responsibility of citizenship, without the first idea of obedience to law and institutions, the very crown and cornerstone of good citizenship, without that most essential asset in the citizen; the power to do prolonged hard work.

And then it is fashionable to be in administrative work. Young men come to college asking for a course leading to the college presidency. Why not? The administrative officers are mentioned in the local paper oftener than any one else. The professor gets no notice unless it be the college green-goods man who sells intellectual gold bricks to the woman's club.

Consequence: Did you ever hear of a college fledgling whose supreme passion was to become a great scholar? Exhibit him, if you have, for he is a *rarissima avis* indeed. No, the premium is not on scholarship, as it is, for example, in the German universities. Thus it comes about that more and more rarely the really capable scholar does not go over to administrative work.

How shall we ever rear a race of scholars when there is neither pay nor honor in scholarship? The scant money compensation is patent, and honor is more than money to the idealist, and such, after all, the college professor is. There was a time when the highest ambition of every German youth was to be a poet. Why? Because two great world-poets were the most honored men in Germany. To-day it is different—every German youth burns to become a soldier, a politician —because these are the honored personages of the realm.

Who upholds scholarship as a great and valuable possession in America? Do we do it even in the colleges? In the smaller colleges the stimulus to scholarship is often wanting. The college library consists of some few thousand volumes of, in great part, antediluvian literature, presented perhaps by some alumnus of that early period, a few books for class readings, and a couple dozen journals. And should the faculty ask for more, the trustees answer them like they answered Oliver Twist: Why there's the *Encyclopedia Britannica* and the whole of the *World's Best Literature:* What more do you want, you snobs?

What shall Oliver do? Oh, occasionally a lively one works hard during vacations and at other times to get something done. But more often he chokes down his intellectual hunger, gets to tinkering with real estate, rubber stock, subsides into nocuous desuetude, and chews his little denominational cud. This brings me to chapter the last, which relates to Rousseau's dictum that a slave can not educate free men.

Students, especially immature ones, will imitate and model after their teachers. I am aware that the present plan of college studies, which, like a hotel dinner, gives you a lot of scraps, the whole not amounting to anything substantial, precludes a student's getting really interested in any branch of study or in any professor. Nevertheless, students will emulate their teachers. The greater the model now, the better for your boy and girl, and anything or anybody that undermines the respect, dignity and worth of the teacher, that makes him "unfree" is a drawback to education.

EDWARD WHYMPER: ALPINIST OF THE HEROIC AGE

By Professor B. E. YOUNG
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ON September 16, 1911, there died suddenly at Chamonix, France, a man who made a most unusual figure in his specialty. Most of us must have thought of Edward Whymper as long since dead and gone to the limbo of travelers, for he did his work a generation ago, reached his fame and enjoyed it, and had lately been forgotten, in the general commercialization of sports that has taken place in the last two decades.

Any one who has sojourned in the Alpine region for any length of time has been struck with the enormous number of tourists and sportsmen visiting this chief playground of the nations, and with the extraordinary perfection of the system of taking care of them and meeting their every whim. There are few centers, even the small ones, without their *Club Alpin*. It was not so when Whymper went to the Alps on a professional errand in 1860 and began his career as a climber.

By neither heredity nor environment did Whymper come by his mountaineering. Born in London, April 27, 1840, he was the son of an artist and engraver on wood, who gave him a good education at Clarendon House School and by private tutor, and then trained him carefully and with excellent results in his own profession. By 1860 young Whymper had become an artist of sufficient ability to be sent to Switzerland by a London publisher to make some sketches of the great Alpine peaks, and more particularly to prepare some illustrations which were intended to celebrate the triumph of an English party, headed by Professor Bonney, who intended to make the ascent of Mont Pelvoux in Dauphiny. Whymper states that at this time he had only a literary acquaintance with mountaineering, and had not even seen, much less set foot upon, a mountain. The party of distinguished Englishmen failed in their attempt to conquer this virgin mountain. A very agreeable Frenchman, who accompanied the party, was charmed with Whymper, and begged him to return with him to the assault. In 1861 he did so, and with his friend made the first ascent of Mont Pelvoux; thus was he infected with the love of high places!

In 1861, Edward Whymper found in the Alps none of the modern machinery of mountaineering; there were no railroads to the top of Jungfrau; no railings on the Matterhorn and no hotels on the Mer de Glace; travel was slow, mostly on foot, or by the unreliable diligence,

which took a traveler only to the foot of the lower valleys. Although De Saussure, the Swiss pioneer, had done his work on Mont Blanc as early as 1787, he had had so few successors that he seemed almost a contemporary. Professional guides were few, not especially experienced or adventurous when new territory was contemplated, so that we must not be astonished to find that Whymper, Tyndall, Forbes, Kennedy, Sir Alfred Wills, Sir Leslie Stephen sometimes dispensed with guides or used them more as porters or servants than as advisers.

It was the heroic age of Alpinism. The vast flood of development and facilitation—vulgarization, let us say—did not come until the seventies or eighties. Almost every ascent was a geographical achievement, accomplished by the bitterest toil. The early sixties were a school in which were educated some of the great climbers and explorers of the nineteenth century.

Having learned his first lesson on the Pelvoux, Whymper dallied for no further lessons, but attacked the Matterhorn at once, in his vacation of 1861. The Matterhorn was then the last great Alpine peak that remained unscaled; less on account of the difficulty of the feat than by the doubt inspired by the invincible appearance of the mountain. It was regarded with terror by the climbers and with affrighted superstition by the natives. Even to-day it is dreadfully impressive to the casual tourist; it never seems commonplace and stands almost alone among mountains. It still has no rivals in the Alps for difficulty, and but few in the world.

To-day it is curious to read of Whymper's fruitless searchings here and there to find guides for the Matterhorn. There was apparently only one man in the Swiss valleys who believed that the mountain *could* be ascended, and that was Jean-Antoine Carrel, destined later to become the most famous of guides. With him Whymper made his first attack upon the peak, in August, 1861. One other guide, J.-J. Carrel, accompanied them. They failed, but learned valuable lessons. Similar attempts were made in 1862 and 1863 without success, but all the time Whymper was making marvelous progress as a scientific mountaineer.

Whymper's impatience with his guides led him in 1862 to make another attempt on the mountain alone. Many of us read in our first readers the story of his solitary scramble on the Col du Lion, terminating in a terrific fall down an ice slope. Here he was saved only by a hair from a fall on to the Glacier du Lion, a thousand feet below. This early experience seems to have been a valuable one for him.

In 1864 Whymper turned aside from the Matterhorn to make what seems to the writer one of his chief feats—the ascent of the Pointe des Écrins. This is the highest of the French Alps, and in 1864 was still unconquered. It is an exceedingly steep and smooth tooth of rock.

It was one of the severest climbs that Whymper ever had in his career, full of peril and physical suffering. The party reached the summit by the glacier of the Ancula. Read again Whymper's description of this glacier:

> Imagine a triangular plane 700 or 800 feet high, set at an angle exceeding 50 degrees; let it be smooth, glassy; let the uppermost edges be cut into spikes and teeth, and let them be bent some one way, some another. Let the glassy face be covered with minute fragments of rock, scarcely attached, but varnished with ice. Imagine this, and then you will have a very faint idea of the face of the Ecrins, on which we stood. It was not possible to avoid detaching stones, which, as they fell, caused words unmentionable to rise. The greatest friends would have reviled each other in such a situation.

A few days afterward he climbed the Aiguille Verte, a considerable feat in itself, though Whymper, in his modesty, makes little of it. This was the first of the great Chamonix Aiguilles to be ascended.

It was not until his eighth attempt on the 13th of July, 1865, that Whymper finally attained the summit of the Matterhorn. He left Zermatt at 5:30 in the morning with three guides, Michel-Auguste Croz, whom Whymper loved as a brother, old Peter and young Peter Taugwalder, Lord Francis Douglas, the Rev. Charles Hudson and Mr. Hadow, a young man of nineteen. After long study, Whymper had rejected the usual route up the Matterhorn by the southwest or Italian ridge. Professor John Tyndall and he, in their fruitless emulation of each other, had stuck to this traditional route. Mr. Whymper now determined to try the eastern face, convinced, as he says, that its almost perpendicular appearance from Zermatt was an optical illusion and that the dip of the strata, which on the Italian side formed a continuous series of over-hangs—"ghastly precipices"—on the opposite side would become a great natural staircase with steps inclining inward. This apparently trivial deduction was the key to the ascent of the Matterhorn, and this route has since become the usual one.

All readers of adventure are familiar with this ascent. Sleeping over-night on the mountain, they reached the summit, with severe rock-work just before the finish. On the descent, however, came what is perhaps the most sensational accident, everything considered, in the history of mountain climbing. Let us quote Whymper's own words:

> A few minutes later (that is, just after the descent was undertaken) a sharp-eyed lad ran into the Monte Rosa Hotel (at Zermatt), saying that he had seen an avalanche fall from the summit of the Matterhorn on to the Matterhorngletscher. The boy was reproved for telling idle stories: he was right, nevertheless, and this was what he saw. Michel Croz had laid aside his axe, and in order to give Mr. Hadow greater security was absolutely taking hold of his legs and putting his feet, one by one, into their proper positions. As far as I know, no one was actually descending. I can not speak with certainty, because the two leading men were partially hidden from my sight by an intervening

mass of rock, but it is my belief from the movements of their shoulders, that Croz, having done as I have said, was in the act of turning round to go down a step or two himself; at this moment Mr. Hadow slipped, fell against him and knocked him over. I heard one startled exclamation from Croz, then saw him and Mr. Hadow flying downward: in another moment Hudson was dragged from his steps, and Lord F. Douglas immediately after him. All this was the work of a moment. Immediately we heard Croz's exclamation, old Peter and I planted ourselves as firmly as the rocks would permit: the rope was taut between us, and the jerk came on us both as on one man. We held, but the rope broke midway between Taugwalder and Lord Francis Douglas. For a few seconds we saw our unfortunate companions sliding downward on their backs, and spreading out their hands, endeavoring to save themselves. They passed from our sight uninjured, disappeared one by one, and fell from precipice to precipice on to the Matterhorngletscher below, a distance of nearly four thousand feet in height. From the moment the rope broke it was impossible to help them. So perished our comrades.

Only Whymper and two of the guides were saved by the breaking of the rope.

For the space of half an hour we remained on the spot without moving a single step. The two men, paralyzed by terror, cried like infants. . . . Old Peter rent the air with exclamations of "Chamonix! Oh, what will Chamonix say?" He meant, "Who would believe that Croz could fall?" The young man did nothing but scream or sob, "We are lost! we are lost!" Fixed between the two I could neither move up nor down.

It was hours afterward before they descended the mountain and some days before the bodies of three of the unfortunates were rescued; that of Lord Francis Douglas was never found. Some day, perhaps, it will come forth fresh and life-like from the foot of the glacier.

Such were the difficulties of Alpine climbing in 1865. Scarcely can we realize to-day what an achievement this was. Says Javelle in his "Souvenirs d'un Alpiniste":

After the first ascent of Mont Blanc and until that of Everest the most *beautiful* conquest of the climbers is certainly the Matterhorn.

Besides his own trials, Whymper describes seven other well-organized attempts to scale the mountain that had been made during the half-dozen years preceding his achievement. The fearful cold, snow storms and almost cyclonic winds of the upper reaches, contributed to the discomfiture of these earlier parties. One might add that while these other climbers were fine, bold mountaineers, they lacked the extraordinary preparedness and resourcefulness, amounting almost to luck, of Edward Whymper.

It may be said that this ascent made little direct contribution to the sum of knowledge. It did have the effect, however, of awakening a widespread interest in the Alps. Of course, the terrible accident contributed not a little to this result. The next few years witnessed the

outburst of British energy, which brought the subjugation of all the higher Alps, until the ascent of the Meije in 1877. This was the last great Alpine peak to be conquered. From the pioneering of Whymper and his brethren came the widespread efforts which have left only a few great summits on the globe still unconquered.

These and other achievements of Mr. Whymper in the Alps are set forth in his famous book, "Scrambles among the Alps in the Years 1860–1869." The beautiful illustrations were engraved by the author himself, and they have been copied numerous times in books of travel. This absorbingly interesting little volume now commands a premium among collectors. It is at once a thrilling tale for children about the family fireside; a guide-book for the amateur; a style book for the writer of travels. Forty years have improved its flavor but have not dimmed its charm or usefulness.

Whymper returned to England to find himself grown famous in a night. The sad fatalities of his expedition did not shake his nerve. He was soon on the road again, this time visiting Greenland on an important expedition in 1867. The fine collection of fossil plants and Eskimo relics which he made on this occasion and upon a later visit in 1872, are now preserved in the British Museum. He also proved, by the discovery of magnolia cones, that Greenland was once covered by luxurious vegetation. His able review of this work was published in the *Report* of the British Association for the year 1869. Though the Greenland expedition was not the success that Whymper hoped it would be, for he was hampered by lack of financial backing and by the prevalence of an epidemic among the natives, yet he not only made important researches in the fauna and flora of Greenland, but he proved that the interior could be explored by the use of properly constructed sledges, and thus contributed to the advance of Arctic exploration and to the ultimate discovery of the pole. The expedition of 1872 was devoted to a survey of coast line. Although a busy artist, he found sufficient vacation every year to do some valuable climbing or exploration.

It was in 1879 that Whymper undertook his notable journey to the Ecuadorian Andes. He had contemplated going to the Himalayas, and in 1874 had projected a scheme which would have taken him to this, probably the most difficult mountaineering ground on the globe. He proposed to carry his exploration and research up to the highest attainable limits. Just at the time it was possible to start, the British Government entered upon the construction of a "scientific frontier" for India, and rendered that region unhealthy for any but soldiers. Whymper then turned to South America. Perhaps he would have preferred to go to Peru or Chile, but owing to unhappy local dissensions

he turned to the Republic of Ecuador, the most lofty country which remained accessible.

Since his achievements in the Alps he had turned more and more toward the scientific side of mountaineering. The main objects of his South American journey were to observe the effects on the human body of low pressure and to attain the greatest possible height in order to experience it; to determine the relative altitudes and positions of the chief mountains of Ecuador; to make comparison of boiling-point observations and of the aneroid barometer against the mercurial barometer; and to make collections in botany, zoology and geology at great heights. He concerned himself neither with commerce nor politics, nor with the natives and their curious ways, except incidentally.

He had not the means to project a great scientific expedition; his staff was modest, consisting of his old Alpine guide, Jean-Antoine Carrel; a cousin, Louis Carrel, with a third man picked up in Ecuador. Landing at Guayaquil on December 9, 1879, he proceeded at once up the Guayas River to Bodegas, and thence to the plateaus of the great extinct volcano Chimborazo. After a careful examination of the mountain—referring to the accounts of Humboldt in 1802 and Boussingault in 1831, from which he did not, after all, receive much aid—he attacked the mountain on December 27. On December 28 he and his two European guides were stricken with mountain-sickness for the first time, with intense headache, feverishness and disturbance of respiration. Fighting this off and triumphing over constant delays due to inefficient help, he finally reached the top of Chimborazo on January 4, 1880. On this ascent he took constant readings of the barometer and thermometer, and of the variations of the weather. He fixed the height of the summit at 20,545 feet. This is all set forth in the most interesting fashion in his "Travels Amongst the Great Andes of the Equator," New York, 1892.

Whymper met few of the greater perils of mountain-climbing in Ecuador that he had suffered in the Alps. He suffered more from annoyances, such as snow-blindness, frost-bites, inefficiency and thievery on the part of the natives, almost incredible sanitary conditions in the inns and tambos. All his party developed complaints of one kind and another.

From Chimborazo he went on to the conquest of Corazon, Cotopaxi —where he spent the night on the cinder cone in the very edge of the crater—Illiniza, Sincholagua, Antisana, Cayambe, Sara-Urca and others. His description of the sojourn on Cotopaxi makes thrilling reading. His own beautiful engravings add great interest to this account.

Whymper enjoyed adventures when they came, but above all he

tried to make this visit a scientific one. He secured extremely valuable collections of the earthworms, beetles, centipedes, dragon-flies, butterflies, ants, moths, scorpions, crustacea and the ferns and lichens of the greatest altitudes. He was a man who knew just what was worth collecting, and brought back numerous totally new species. He was able also to collect quite a number of unusual ornaments, weapons and implements made by the tribes of prehistoric days, and choice specimens of volcanic rocks and dust. He had the good fortune to be on the top of a near-by mountain at the time of an eruption of Cotopaxi; he saw its very beginning and observed its progress; and has left us admirable notes of the phenomena.

His observations on mountain-sickness led him to conclude that it was caused by diminution in atmospheric pressure, operating in at least two ways: by lessening the value of the air that can be inspired in any given time, and by causing the air or gas within the body to expand and to press upon the internal organs. In the second case, the effects may be temporary and pass away when equilibrium has been restored between the internal and external pressure.

The publication of his work on Ecuador was recognized by the Royal Geographical Society, which made him a fellow, and gave him the "Patron's Medal." The Royal Society of Edinburgh made him a fellow and the Italian King made him a Knight of the Order of St. Maurice and St. Lazare. Honorary memberships in geographical and mountain-climbing clubs of Europe and America were thrust upon him.

His experiences in South America convinced him that the aneroid barometer was unreliable at high altitudes, and he published a work on "How to Use the Aneroid Barometer," 1891, and succeeded in causing important improvements in the construction of this instrument.

His extensive observations of glaciers led him to attack those who claimed for glaciers great powers of erosion. He considered them of secondary importance to the great forces of expansion and contraction in the breaking-down of rock structures of the mountains. He conceded that glaciers carried down large quantities of material, but would not concede that they created much of this material. Everywhere he went he set down interesting geological observations.

Whymper's reputation as a mountaineer put him in demand for articles on the Alps. In 1896, at the instance of John Murray, the London publisher, he gathered a great quantity of information into a "Guide-book to Chamonix and Mont Blanc" (206 pp.). This book soon became the standard of its kind. It has had an immense sale, reaching its fifteenth edition in 1910. In 1897 Murray brought out Whymper's "Guide Book to Zermatt and the Matterhorn," which is, if

anything, a still more ambitious work in two hundred and twenty-four pages, profusely illustrated, and filled with the most interesting and advantageous information. In 1911 this also attained its fifteenth edition. The same scientific spirit that made his earlier books so attractive and reliable is inevitably present even in a popular guide book.

The oncoming of old age did not retire Whymper to a chimney corner. In 1901 he made an exploring expedition in the Great Divide of the Canadian Rockies. He repeated this visit four times, also pushing on to the Selkirk Mountains.

We have no record that he ever undertook a voyage to the Himalayas after his disappointment in 1874. It is significant that his death took place at Chamonix. It may be that, feeling the approach of dissolution, and unwilling to die in his bed, he was about to undertake another ascent of Mont Blanc, "the great White Mountain" of which he never grew tired.

Edward Whymper was not a transcendentalist or an esoteric in mountain climbing. He employed his best descriptive talents and his charming humor of the best British variety in his descriptions; he knew the mountains in their secret moods; but he seldom broke out into poetry. There is no record of revelry by night, or of singing Alpine pæans before breakfast. He seems to have gone about mountain climbing seriously, yet pleasantly withal. No dangers affrighted him, but, on the other hand, he did not seek extraordinary gymnastic feats. It is safe to say that he had ingrained in him true love for the mountains, and a great delight in the views from above the clouds, but he was also imbued with the savage lust of exploration and pioneering.

We may live to see a school of climbers that may accomplish more things than his, but we shall not see one of more heroic spirit.

The world owes him something more than a reputation of an undaunted climber of mountains or a fame that can be assessed in worldly terms. Zermatt owes him a statue, no less than Chamonix owed to De Saussure and Balmat.

ALCOLOL FROM A SCIENTIFIC POINT OF VIEW

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SOME problems permit of a ready and satisfactory solution with but little difficulty, while in fullness others remain obscure for generation upon generation, being resolved slowly and at great pains. In the latter class stand the problems involved in the study of alcohol. Some of these, although investigated for centuries, have been but recently solved or are still in the process of solution. Other associated problems remain which are but little better understood to-day than they were in the time of Aristotle.

Of this group of problems, solved or in the process of solution, I should like to consider in order the following parts:

Alcohol: I. Its Discovery and Nature.
II. The Relative Toxicity of the Various Alcohols.
III. The Destiny of Alcohol in the Body.
IV. The Action of Ethyl Alcohol on the Body and on its Output of Physical and Mental Work.

I. The Discovery and Nature of Alcohol

Through many ages nature has been elaborating a substance which has come to affect human progress most profoundly. This substance we to-day call alcohol. Although the existence of alcohol was surmised almost four centuries before the Christian era, yet practically twelve centuries intervened before its extraction, and ten centuries more elapsed before its nature and the biological significance of its origin were fully made out.

To appreciate the conditions confronting men who attacked problems of the sort in the infancy of science, we should look back to those ages in which natural phenomena called forth extravagant explanations, a day when apparatus and laboratories were unknown and, above all, a time when the scientific momentum, which is ours because they labored, was yet unborn. Under such conditions the work on alcohol was begun.

Alcohol Early Detected in Wine

Two important observations were early made concerning wine. The first of these was that wine, unlike water, if thrown into the fire emits a flame. When questioned as to the cause of the phenomenon Aristotle answered that the flame was due to an exhalation contained in the wine. Later, Pliny related that the wine from Falernus Ager blazed up at the contact of a flame—a wine, as Berthelot remarks, evidently rich in inflammable exhalation.

Since men of that period knew that sea water vaporized and con-

densed was drinkable, we might expect that it was but a step to the extraction of the inflammable exhalation. But a long step it proved to be! An attempt at condensation was in fact made at that time with the result that wine upon evaporation became water.

It was not until the fourth century of the Christian era that an adequate distilling apparatus was perfected; and this, although used in the distilling of various substances, seems not to have been employed for the production of alcohol. Not until the writings of Marcus Græcus, in fact (twelfth or thirteenth century),[1] do we get unmistakable evidence of the distillation of alcohol—the distillate obtained being called "aqua ardens."

An explicit account of the process of distillation and a description of the characteristics of the alcohol thus obtained occur in a Latin manuscript published about 1438—but which according to Berthelot contained older excerpts. In this the preparation of alcohol is described as follows:

> Take good old wine, any color; distil it over a slow fire (in a still and an alambic closely joined). The product of distillation is called "aqua ardens."

To "aqua ardens" are ascribed the following characteristics which we to-day associate with alcohol.

> Moisten a linen cloth in it, and light it. It will produce a great flame; when it has gone out the cloth will remain intact. If you put your finger in this aqua (ardens) and light it, it will burn like a candle without causing injury. If you put a lighted candle in it the candle will not be extinguished.

Thus from the time of Aristotle to the period immediately following that of Marcus Græcus there elapsed an interval of considerably more than a thousand years in which through extended effort, the exhalation of wine was eventually obtained. As time passed methods were devised by which aqua ardens was procured in greater concentration. It should be stated, however, that the word "alcohol" as applying to present-day alcohol was not used until the sixteenth century and further that alcohol in the purity in which it is now obtained is a product of the century just passed.

The second of the early discoveries made in the study of wine was that of its stimulating effect on man. An interpretation of this effect in later years greatly influenced the use of alcohol. Prominent in this interpretation stands the name of Arnaldo de Villaneuva. In his work entitled "The Conservation of Youth" (1309) after speaking of the delicacy of the nature of the spirit of wine, and enumerating the various maladies cured by it, he adds that the spirit of wine should be called "eau de vie,"[2] for it prolongs life.

From the time of Arnaldo de Villaneuva to the present there has been growing a counter belief in the minds of many that the prolongation of life is not one of the characteristics to be associated with "eau

[1] Some give the date of Marcus Græcus in the eighth century.

[2] Eau de vie—The elixir of life.

de vie." Indeed, some believe that "eau de vie" curtails rather than prolongs life, and some there are who go so far as to maintain that "eau de vie" should be called "eau de mort."[8] But this is aside from the subject! It is of interest, however, to note that out of the opinion expressed by Arnaldo de Villaneuva probably grew the prevailing belief in Europe in the efficacy of the daily use of brandy, and to the latter may be attributed the custom of the mint julep or so-called old-age drink prevalent in parts of our own south.

Alcohol Discovered in Substances other than Wine

Man, seeking ways of producing alcohol from substances other than wine, early made the important observation that fermentation and the production of alcoholic liquids go hand in hand. This discovery, as time passed, became common knowledge, with the result that fermented liquids from different sources came to be looked upon as characteristic national drinks—thus in France *wine* from grapes, in Jamaica *rum* from cane, in Russia *vodka* from rye, in Japan *saki* from rice, in Germany *beer* from barley and in America *whiskey* from Indian corn.

But some substances long used in the formation of alcohol, unlike the juice of grapes, are themselves unfermentable. Some of these we shall consider more in detail.

Common or cane sugar, although of itself incapable of undergoing alcoholic fermentation, by the action of a ferment invertase, takes up a molecule of water, splitting into glucose and fructose, both of which are fermentable. Thus cane sugar, $C_{12}H_{22}O_{11} + H_2O$, becomes $C_6H_{12}O_6$ (glucose) and $C_6H_{12}O_6$ (fructose). From the fermentation of glucose and fructose alcohol results.

The starch of cereal grains when converted into *fermentable sugar* likewise becomes an effective source for alcoholic fermentation. It has long been known that a starch paste, to which malt or malt extract (containing diastase) has been added, becomes transformed into a sugar maltose. Now maltose itself is not subject to alcoholic fermentation, and so it must be acted upon by another ferment, maltase. This converts the maltose into dextrose and glucose, the latter of which we have seen to be produced in the case of cane sugar.

In 1837 Cahours employed potatoes as a source for alcoholic fermentation. The starch of potatoes is insoluble in cold water, but upon heating it in the presence of dilute sulphuric acid the starch is converted into fermentable sugar. In this process in addition to the ethyl alcohol produced a considerable amount of one of the higher alcohols, amyl alcohol, was discovered.

Two years earlier than the discovery of amyl alcohol another alcohol was obtained. This was produced not by fermentation, but by the destructive distillation of wood, and was therefore called wood or methyl alcohol.

[8] To be seen on the walls of one of the well-known sanatoria of France.

This alcohol is obtained by distilling the wood in iron retorts at a high temperature (about five hundred degrees C.). The vapors thus driven off when condensed are found to contain, in addition to a large percentage of methyl or wood spirit, acetone, acetic acid, etc. Upon being freed from these foreign substances methyl alcohol is obtained in purity.

Concentration and Purification of Alcohol

The alcohol obtained at the time of Marcus Græcus contained a relatively large amount of water and in addition numerous foreign substances. To remove these was the task set for succeeding workers. It was found that the percentage of aqua ardens could be perceptibly raised if the alcohol collected be redistilled. If the process of redistillation be repeated a number of times, a concentration approximating 90 to 95 per cent. was possible.

In the present-day commercial manufacture of alcohol the apparatus has been so perfected that by a single distillation an equally high percentage is obtainable.

By neither of these methods, however, is it possible to render alcohol anhydrous, or free from water. But alcohol of a relatively high percentage placed in contact with a chemical, such as caustic lime or baryta having a strong affinity for water, and then redistilled may be rendered practically free from water.

The foreign substances present in the alcohol were found to be principally glycerin, succinic acid and higher alcohols, traces of several of the latter, such, for example, as propyl, butyl and amyl alcohol, being found in ethyl alcohol.

To separate amyl alcohol from ethyl it is necessary to employ a physical property which in the different alcohols is perceptibly different —that is, the boiling points. While ethyl boils at 78.4° C., propyl at 97° and butyl at 117°, amyl does not reach its point of ebullition until it is elevated to a temperature of 132° C.

It would therefore appear that the separation of amyl alcohol from ethyl would be easily effected by raising the temperature of the mixture to 78.4° C. and thus driving off the ethyl alcohol. This is in fact the method used, but it is found that while the first part of the distillate is largely ethyl, later amyl is also given off at a temperature far below its boiling point. In a word a single distillation is by no means sufficient to separate the two. By a process known as fractional distillation, it has been found (Roscoe and Schorlemmer) that when a temperature of 80 to 90° C. is employed 88.1 per cent. of ethyl alcohol is distilled off and that 11.9 per cent. of amyl also passes over. In the case when the temperature is raised from 131 to 132° C. 0.2 per cent. of ethyl is still obtained and 99.8 per cent. of amyl.

Since the boiling points of propyl and butyl alcohol approximate

more nearly that of ethyl, it is practically impossible, even by repeated fractional distillation, to remove *all* traces of these.

The alcohols with a higher boiling point are also found to differ from ethyl alcohol in another respect—that is, in their chemical form or molecular weight. The molecular weight of ethyl alcohol taken as a standard is 46; that of propyl, 60; that of butyl, 74; and that of amyl, 88. It is thus seen that in both molecular weight and boiling point, alcohols of fermentation fall into a regular series ascending from ethyl to amyl.

In addition to the above alcohols of fermentation is wood or methyl alcohol which reaches its boiling point at only 66° C. (or 66.5°) and has a molecular weight of 32.

The molecular weights and boiling points found for the primary alcohols named may be briefly summarized as follows:

Alcohol	Molecular Weight	Boiling Point
Methyl	32	66.0° C.
Ethyl	46	78.4° C.
Propyl	60	97.0° C.
Butyl	74	117.0° C.
Amyl	88	132.0° C.

The Biological Significance of Fermentation

While the production of alcohol has long been associated in the minds of all peoples with the process of fermentation, yet the exact nature of the process was unknown until the significant work of Pasteur appeared. Pasteur in his work on fermentation, as in all his work, was unwilling to accept blindly an interpretation of the meaning of the process until he had examined in detail and elucidated step by step the actual occurrences taking place.

By taking the juice of the grape he observed, as had often been observed before, that upon leaving it for a time at a warm temperature, bubbles of gas arose. This gas was evidently the result of a chemical process going on within the mixture. But to Pasteur is due the credit of showing for the first time that within the mass of grape juice the thousands of living organisms (which Latour, Schwann and others had already seen) were busily engaged in the process of digesting a part of the sugar contained in the juice. Pasteur believed that these living organisms, by taking oxygen from the sugar, caused the splitting up of the sugar into two substances. One of these he had seen arising as bubbles of gas—carbon dioxide—the other remained in the mixture, gradually increasing in strength as more and more was produced. The latter substance Aristotle had spoken of as the exhalation of wine. Marcus Græcus denominated it aqua ardens. We call it alcohol. The organisms which thus produce alcohol are the yeasts, many kinds of which are now known.

To Pasteur fermentation was life without air. That is, the yeasts

living in a liquid medium in order to secure sufficient oxygen procured it from the sugar, thus, as we have said, producing from the latter CO_2 and alcohol. The production of alcohol hence resulted as a product of metabolism in the body of a living organism.

It has been more recently shown, however, that the active cause of fermentation is to be found not in the yeast itself, but in a ferment (or enzyme) produced by the yeast cell. This ferment Büchner has succeeded in freeing from the cell, so that it is now possible to produce alcoholic fermentation without the presence of the living yeast.

But this discovery does not detract from the work of Pasteur, to whom is due the great credit of definitely showing the importance of living organisms, the yeasts, in the production of alcohol, since without the yeast cell the ferment or enzyme would not be produced.

The nature of the experiments by which Pasteur demonstrated the importance of the yeast is of interest. In the first place he showed that grape juice filtered and kept from contact with the air is not subject to alcoholic fermentation. In the second case he demonstrated that grape juice sterilized by heat is, if similarly protected, unfermentable. In the third case he showed that if the yeasts caught on the filter used in the first series of experiments be added to the sterile juice of the second series, fermentation ensued.

Pasteur was asked the origin of the yeasts which make the alcohol in wine. The question was answered by an experiment. Taking the grapes and completely removing from them the fuzz or "bloom," he extracted the juice free from contact with the air. No fermentation followed, consequently no alcohol resulted. From this it was learned that the yeasts necessary for the production of the alcohol of wine live in nature in the air and are found in abundance on the outside of the grape. If the grapes be crushed the sweet juices serve as food for the yeast plants. These when well fed grow rapidly and, by a simple process of budding, produce myriads of yeast plants. These, like their parents, give rise to ferments which break down the sugar into CO_2 and alcohol.

It was later found that although these yeasts may increase greatly in numbers, a strong percentage of alcohol is impossible in nature. This is due to the singular fact that when the strength of alcohol increases perceptibly the organisms forming it are unable to thrive in their own product. Hence they increase more slowly. When a strength of 12 per cent. of alcohol is reached reproduction is manifestly checked, and at 14 per cent. all cell activity ceases.

To increase the strength and purity of the alcohol thus formed in nature, man, as we have seen, has resorted to the processes of distillation and rectification by which alcohols practically free from impurities may be obtained in concentration.

THE BIOLOGICAL STATUS AND SOCIAL WORTH OF THE MULATTO

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THE United States has something more than a "negro problem"; it has a mulatto problem. Our 10,000,000 colored fellow-citizens comprise somewhat less than 8,000,000 full-blooded negroes; approximately 2,000,000 contain varying percentages of "white" blood. This "white man's burden" has several cardinal aspects, notably, social, economic and political. The fundamental aspect, however, is the biologic. Does the presence of this vast company of "half-breeds" complicate or facilitate the "problem"? Certain it is that they must be reckoned with. Are they an aid or a hindrance to a permanent satisfactory adjustment of full relationship between the white race and the colored? To one man their presence is a source of black despair, to another of radiant hope. Which is the more rational attitude? It depends upon the scientific facts in the case. The first point concerns the biological status of this mulatto hybrid.

It may help the subsequent discussion to note at this point the fact that Jamaica does not have a "negro problem" as we know it in the United States. And on the face of things it would appear that it might well be present there in even more aggravated form. For in Jamaica there are only about 15,000 whites among a colored population of about 700,000, including about 50,000 mulattoes. It should be noted that in this "Queen of the Greater Antilles" the mulattoes, as a class, are more nearly at the level of the whites than at that of the pure negroes. The mulattoes contribute the artisans, the teachers, the business and professional men. They are the very backbone of wonderful Jamaica. To be sure, Jamaica has had 30 years more than the United States during which to "solve" her "negro problem." But perhaps the perfect adjustment between the races in Jamaica and the elimination of any "problem" of this kind finds its explanation in a more rational and more consistent political treatment made possible by the absence of any constitutional prescription. We may well suspect that the inconsistency of according to the negro legal (constitutional) equality and withholding it practically (politically and socially) has had a morally harmful effect upon both black and white. To stultify oneself as between one's theory and practise is always subversive of high moral tone. We shall return to this point below.

Suffice it to note here that the Honorable Mr. Olivier, governor of Jamaica, recognizes in the presence of the mulatto only a past blessing, a present advantage, and a future promise of great good.

In the beginning we shall need to raise the question once more as to whether the Negro and Caucasian are actually different man-species, as was held by the eminent zoologist, Louis Agassiz, and as is still held by many, as, for example, the noted French psychologist, Le Bon; or whether they simply represent different "races" or varieties of the same species *homo,* as is more commonly believed. Le Bon quotes with approval:

> If the Negro and the Caucasian were snails, all zoologists would affirm unanimously that they constitute excellent species, which could never have descended from the same couple from which they had gradually come to differ.[1]

However, simply external gross appearance is no infallible criterion by which to judge of species. And the more highly developed the organism the wider do the individuals differ within the species. Two human brothers may differ infinitely more than two true snail-species. Zoology can furnish many examples where a larval form, or individuals of opposite sex, or the same form modified by peculiar environmental conditions, have been mistaken for separate species. The real scientific test is that of impossibility of effecting a cross, or of infertility *inter se* of hybrids of a possible cross. A cross between the horse and the ass produces a mule. But mules are infertile if interbred. Hence horse and ass are separate species. A very valuable cross can also be effected between the cow and the buffalo. But the offspring are barren bred among themselves. Hence cow and buffalo are at least of different species. The mulatto is the product of a negro-white cross. He is as fecund with his own kind, or when he mates with white or negro, as either pure-breeding negroes or whites are. As a matter of fact, the mulatto is probably more prolific than the normal average of either white or negro. During the past twenty years he has increased at twice the rate of the Negro. The Negro is then simply a black variety of the human species. He is the white man's brother; and we may both be cousins of the apes.

The second question that presents itself is this: Is the mulatto necessarily degenerate? The idea has been and is very eminently and widely held that the crossing of races is intrinsically bad, biologically harmful; that it inevitably and inexorably works deterioration. Agassiz noted in Brazil a

> decadence that results from cross-breeding which goes on in this country to a greater extent than elsewhere. This cross-breeding is fatal to the best qualities whether of the white man, the black, or the Indian, and produces an indescribable type whose physical and mental energy suffers.

[1] "The Psychology of Peoples," New York, 1912, p. 4.

Humboldt and Darwin held the same opinion. Hilaire Belloc in "The French Revolution" notes regarding Marat

> Some say . . . that a mixture of racial types produced in him a perpetual physical disturbance: his face was certainly distorted and ill-balanced (p. 78).

Schultz claims to have noted an intrinsic deterioration in Gentile-Jew crosses. Le Bon expresses himself as follows:

> To cross two peoples is to change simultaneously both their physical constitution and their mental constitution . . . the first effect of interbreeding between different races is to destroy the soul of the race, and by their soul we mean that congeries of common ideas and sentiments which make the strength of people, and without which there is no such thing as a nation or a fatherland . . . a people may sustain many losses, may be overtaken by many catastrophes, and yet recover from the ordeal, but it has lost everything and is past recovery, when it has lost its soul (pp. 53–55).

Le Bon explains this supposed necessary degeneration in half-breeds as due to the "influence of contrary heredities" which "saps their morality and character." We shall return to Le Bon's idea of a loss of "soul" as consequent of inter-racial crosses.

This same idea of necessary degeneracy in cross breeds is the main motive of much opposition to foreign immigration. We shall see that this is the very least element of danger; in fact, it may be a real panacea to other actual evils of immigration, otherwise (*i. e.*, without neutralization through cross-breeding) a serious menace. Note here the superb products of the English, German, Dutch, French and Spanish crosses of late and post-colonial days. The superiority of especially the English-German crosses, very generally noted, finds its reason in the initial superiority of the crossing stocks. And this is the secret of the entire matter. Offspring take after their parents, whether these be of the same or different race. The production of the Boer race, one of well-marked physical and mental characteristics, notwithstanding that it is of mongrel immigration, Dutch, French, and in some degree, British, is sufficient disproof of inherent hurt in inter-racial crosses. The more progressive of "white" nations have been produced by European interbreedings, for example, the English and the Bulgars. Furthermore, Davenport reminds us of probably even Ethiopian contributions to our European stock, "when we stop to consider the slaves, not only white and yellow, but also brown and black, that were brought to Rome, became free there and contributed elements to the population of Italy and to all Europe." Indeed, this may well have been a partial source of the pigment of European brunets.

Thoroughbred parents produce similar progeny. Inferior or degenerate parents have only defective children. In proof of which the following: Probably the most brilliant student I have ever known is the son of a high-class Chinese woman by an American missionary. There is probably as great a difference, from a general anatomical viewpoint,

exclusive of skin-pigment, between a Chinese and Caucasian as between a Negro and Caucasian. Similarly with respect to a number of Caucasian-Japanese crosses. There is no instinctive revulsion against such alliance; hence they are frequently made by superior individuals; and the offspring are of the same superior type, without evidence of deterioration. Indeed, it frequently happens that an unusually fortunate combination of the best racial characteristics of both races appears in an offspring of such cross, resulting in an extraordinarily endowed human being.

I admit the general inferiority of black-white offspring. Defective half-breeds are too prevalent and obtruding to permit denying the apparently predetermined result of such crosses. But I emphatically deny that the result is inherent in the simple fact of cross-breeding. There are not a few very striking exceptions among my own acquaintances. Absolutely the best mulatto family I have ever known traces its ancestry back on both the maternal and paternal side to high-grade white grandfathers and pure-type negro grandmothers. The reason for the frequently inferior product of such crosses is that the better elements of both races under ordinary conditions of easy mating with their own type feel an instinctive repugnance to intermarriage. Under these usual circumstances a white man who stoops to mating with a colored woman, or a colored woman who will accept a white man, are already of quite inferior type. One would not expect superior offspring from such parents, if it concerned horses or dogs. Why should we expect the biologically impossible in the case of man? If the parents are of good type, so will be the offspring. And even with the handicap of frequently degraded white ancestry, the mulatto of our country, as in Jamaica, forms the most intelligent and potentially useful element of our colored population.

The fact then is established, beyond all possibility of disproof, it seems to me, that a negro-white cross does not inherently mean degeneracy; and that the mulatto, measured by present-day standards of Caucasian civilization, from economic and civic standpoints, is an advance upon a pure negro. In further support of the potency of even a relatively remote white ancestry may be cited the almost unique instance of the Moses of the colored race, Booker T. Washington. As one mingles day by day with colored people of all grades and shades, one is impressed with the significance of even small admixtures of Caucasian blood. What elements of hope or menace lie hidden in these mulatto millions? How can they help to solve or confuse the "problem"?

Let us see clearly what we are dealing with. What are the large distinctive characteristics of the three types, white, mulatto and black, forming our civic and social complex? As to the negro—I quote from Le Bon:

Above the primitive races are found the inferior races, represented more especially by the negroes. They are capable of attaining to the rudiments of civilization, but to the rudiments only. They have never been able to get beyond quite barbarian forms of civilization, even where chance has made them the heirs, as in Saint Domingo, of superior civilization. . . . The inferior races further display but an infinitesimal power of attention and reflection; they possess the spirit of imitation in a high degree, the habit of drawing inaccurate general conditions from particular cases, a feeble capacity for observation and for deriving useful results from their observations, an extreme mobility of character, and a very notable lack of foresight. The instinct of the moment is their only guide (pp. 27–30).

The common European estimate of the negro, according to Olivier, is that

he is brutish, benighted and unprogressive, . . . "half-devil and half-child" ("White Capital and Coloured Labour," London, 1910, p. 2).

My own experience compels me to accept Le Bon's estimate as applicable to our American pure negro in perhaps slightly less extreme form, and with occasional exception; but "devil" is no more applicable to him than to white "brutes." Le Bon's description would seem to describe fairly accurately the racial characteristics of the negroes. The opinion of many men with whom I have discussed this matter confirms me in this judgment. The average of the Caucasian race is by implication characterized by the opposite traits of the typical negro.

The negro differs from the Caucasian in several well-marked anatomical characteristics. Any one who has associated with negroes detects even more striking mental or temperamental differences. These are quite obvious to teachers of mixed schools, fairly common in certain northern states. Where negro, mulatto and white are jointly concerned the teachers are unequivocal in their opinion that mental alertness and the development of the higher psychical activities corresponds in degree quite uniformly with the amount of "white" blood as judged by color of the skin. Le Bon also is quite emphatic on this point:

Each race possesses a mental constitution as unvarying as its anatomical constitution (p. 6).

and

The mental abyss that separates them (negro and white) is evident (p. 28).

This "mental constitution" is the source of a race's "sentiments, thoughts, institutions, beliefs and arts," its "soul."

Where does the mulatto stand with respect to negroes and whites? In general, as a race, approximately midway. But it includes types combining the best as well as the worst of both races. The former almost certainly predominate at the present time.

In Jamaica, according to Governor Olivier,

In practise it is the fact that the pure negro does not show the business capacity and ambition of the man of mixed race, and there are few, if any,

persons of pure African extraction in positions of high consideration, authority or responsibility (p. 34).

Respecting the status and worth of the mulatto in Jamaica, Governor Olivier expresses the opinion that he is

an acquisition to the community, and, under favorable conditions, an advance on the pure-bred African . . . an indispensable part of any West Indian community, and that a colony of black, colored and whites has far more organic efficiency and far more promise in it than a colony of black and white alone. . . . The graded mixed class in Jamaica helps to make an organic whole of the community and save it from the distinct cleavage (p. 38).

The mulatto has appeared through the white man's acts. He will greatly increase in the coming generations, by breeding with both his kind and with pure negroes. A high fertility is increased relative to the negro by a lessening death-rate. It is fortunate that he represents an advance on the negro, and a real national advantage in our efforts to adjust the negro "problem."

Three further questions must be considered before a summary can be given of the mulatto's social and civic value. (1) Are there fairly well-fixed upper limits of mental capacity for negroes and mulattoes? (2) What are the known and established principles of inheritance of racial traits of negroes and whites; in other words, will it be possible by some control of hybrid and inter-racial crosses to produce a colored stock in which a majority may combine the desirable traits of both white and negro? (3) Will it be possible under the constitution and its present amendments to deal with the problem in accordance with the dictates of science and common sense?

With respect to the first point then: We have here only opinion; but it is absolutely unanimous: the negro can not undergo mental development beyond a certain definite maximum.[2] The curious thing

[2] Since this was written I have seen practically the contrary conclusion stated by Professor Herbert Adolphus Miller, of Olivet College, Michigan, in a work which he has kindly permitted me to read in manuscript and from which he allows me to quote. This is a splendid investigation, unique from the standpoint of its materials, and marked especially by originality and caution. In essence it is exactly the sort of research I am pleading for in my paper. "Psychophysical tests" were "given to 2,488 Negroes, 520 Indians and 1,493 Whites, including 596 Mountain Whites in the Tennessee and Kentucky Mountains." Six tests were employed for (1) Memory (*a*) discontinuous; (*b*) logical; (2) Rational Instinct; (3) Imagination; (4) Color Choice; and (5) Reaction Time. He summarizes his conclusions as follows: (1) There is no sharp line of demarcation between the races within the range of the given tests; (2) the differences are of degree, not of kind; (3) this degree is not a race-limitation, for many whites are inferior to many negroes, even in logical memory; (4) from the standpoint of original endowment there is nothing in kind to differentiate the negro from the Caucasian; (5) no faculty is lacking in the negro, and there are some that are especially strong; (6) *limits of capacity do not follow race lines* (italics my own.) The question arises as to how far these

is that no attempt is made to establish this opinion on a scientific basis, and to definitely determine that limit of mental development beyond which the law of diminishing returns dictates cessation of effort; and furthermore, that in flat contradiction to this common opinion education is planned in apparent utter disregard of it.

We are now in possession of a fairly precise and very simple method of determining innate mental capacity in the Binet-Simon series of mental tests. These tests ought at once to be applied to several thousand each of negro and colored school children. The results should yield a fairly accurate idea as to the relative capacity for education and the limits for each. This is of very practical importance. If it can be shown that the negro brain has definite, relatively low limits of flexibility and development, money should not be spent in attempting the impossible. This is the more serious in view of the common inadequacy of educational facilities. The limit of economical educative return being determined, the negro should be given the best possible opportunities for reaching the uppermost range. This would be to the best interest of white and negro alike. If the returns indicated, as is commonly assumed, that mulattoes are endowed with a higher educable limit, national interests again demand that they be given means of attaining the maximum capacity.

The point is that our activities along educational lines, seeing that the financial resources of the states most intimately concerned are relatively meager, should follow clearly indicated paths as determined by scientific facts. Even with our present knowledge it would seem that wisdom and foresight should take more practical heed of Booker Washington's keen suggestion and example, namely, that the education of the negro be for the present chiefly along industrial, and secondly moral lines. The Binet tests would also early detect the feeble-minded and mentally defective, an especially serious menace in an already naturally handicapped race. Very rigid safeguards should be provided against the reproductive liberty of these unfortunates, so that the race suffer no internal contamination. A first step in the scientific approach of this fundamental aspect of the "problem" would certainly seem to be the very extensive study of colored mentality by the Binet measuring scale. We shall work largely in the dark until we have this information.

With respect to the second point: Until recently it was believed that mulattoes generally bred true and became progressively lighter

conclusions follow from neglect, or inability, to differentiate the *mulatto* from the *negro*. Moreover, the Binet tests seem to me superior for the purpose in hand to those employed by Professor Miller, and for this reason, and also because scientific work touching so important and serious a matter needs confirmation and reconfirmation, should be used in further more extensive similar investigations.

with succeeding generations. We now know that skin color in inheritance follows in general Mendelian laws of inheritance, frequently giving rise to white and black "sports" in every large family of mulatto children. In accordance with Mendelian principles, the result of a white-negro cross is always brown-skinned, the dark skin color *dominating*. "White" and "black" skin colors are a pair of *unit characters*. White color means the absence of the *determiner* for deep pigmentation in the germ-plasm; dark skin is due to the presence of such *determiner*. When first generation hybrids intermarry, in an appropriately large family there will appear invariably one or several children lighter than either parent, and one or several darker; that is, the "lighter" and the "darker" have reverted to the grandparental character for skin color. This reveals the fact of a *segregation* of the determiners of skin color in the germ-cells, producing a *purity of gametes*.

We are now in possession of facts, thanks mainly to the labors of Professor Karl Pearson and his collaborators at the Galton Eugenics Laboratory, and to Professor Davenport and his staff of assistants at the Eugenics Record Office, showing that the inheritance of several scores of human physical and mental traits are in close conformity with Mendelian formulæ. There is no countervailing fact, and there is much precise and yet more suggestive data, to the assumption that many of the really desirable negro traits (*e. g.*, physical strength, resistance or relative immunity to certain infections, capacity for routine, cheerful temperament, vivid imagination, rhythmic and melodic endowment, etc.) are of the nature of *unit characters* and as such may be transmitted according to fixed laws by simple control of matings.

If a demi-god could thus experiment with human crosses, as biologists now do with animal breeds, a pure race could undoubtedly be established combining the best elements of the negro and the white. I am well aware that little could probably be actually accomplished under present social conditions, even if it were not morally inimical, to make the experiment by legal control of negro and mulatto crosses. But some little could be accomplished by education and the arousing of the sentiment of colored racial pride. The point seems clear that in the presence of 2,000,000 mulattoes, steadily increasing in number, of relatively superior worth to the pure negro, we have a key to the solution of our problem. The mulatto is the leaven with which to lift the negro race. He serves as our best lever for negro elevation. The mulatto does not feel the instinctive mental nausea to negro mating. He might even be made to feel a sacred mission in this respect. The negro aspires to be mulatto, the mulatto to be white. These aspirations are worthy, and should be encouraged. Possibility of marriage

with mulatto would be a very real incentive to serious efforts for development on the part of the negro. The logical conclusion may follow in the course of the ages. At any rate from present indications our hope lies in the mulatto. A wise statesmanship and rational patriotism will make every effort to conserve him, and imbue him with his mission in the interests of the brotherhood of a better man. The problem seems possible of solution only as the mulatto will undertake it, with the earnest help of the white.

But Le Bon tells us the cross-breed has no "soul." Surely a soulless race would be a world calamity! But these words are poetical, not scientific. A mulatto has no more lost his soul in being hybrid or a descendant thereof than I should if I were to take up my abode in Fiji. This would surely hurt. But I should be no less a man for all my mental pain. The experience might conceivably work to the expansion of my soul. The mulatto is as loyal to his country, his friends and his conscience, according to his lights, as a "white" man. He is just as sensitive. He feels as deeply, experiences the same thrills of happiness as other rational human beings. He has a soul in as true a sense as the word is used by Le Bon as any man. He has more truly a soul in this sense than the "thoroughbred" professor who has lost his childhood's religious faith. Olivier says on this point:

> Whereas the pure race in its prime knows one man only, itself, and one God, its own will, the hybrid is incapable of this exclusive racial pride, and inevitably becomes aware that there is something, the something that we call human, which is greater than the one race or the other, and something in the nature of spiritual power, that is stronger than national God or will. What were, to each separate race, final forms of truth, become, when competing in the focus of our human consciousness, mutually destructive, and each recognizably insufficient. Yet the *hybrid finds himself still very much alive, and not at all extinguished with the collapse of his racial theories* (p. 25, italics my own).

The truth is that the hybrid finds himself *alive* and *human,* with all that this signifies in terms of capacity for soul development. The pure-bred has no better initial equipment. In the matter of human fundamentals they come to differ only as a different nurture plays upon a very similar human nature. There surely are no real data for the support of Le Bon's notion that contrary heredities sap the vitality of hybrids and leave them barren of soul.

The last point is equally difficult, but, like the preceding two, not forbidding. It may be briefly more or less summarily disposed of. The negro can not afford to surrender aught granted him under the constitution. It would be harmful to both colored and whites at this stage of progress to have such alteration achieved as would give the governing powers the free hand exercised by the English in their treatment of the negro of Jamaica. A comparison of conditions as between

the United States and Jamaica with reference to its negro population, however, shows us floundering far in the distance. How can English colonial conditions be paralleled without violence to our constitution? By a simple method, apparent to all, the adoption of which would work incalculable benefit to our nation. The canker of our present political condition as it affects the negro is the moral sore of a stultified conscience. Very naturally when the negro realizes that the constitution makes him politically the equal of any white man, while he knows he is an inferior individual, if indeed only in the sense that a child is inferior to an adult, he detects a first inconsistency. This he accepts; and views equal suffrage as a gift. But when he further realizes that equality of suffrage is a theory, which is disregarded in practise, he sees an inconsistency which he resents, and which moves him to loss of respect. This is the root of distrust and dissimulation and antagonism, which is at the source of the troubles which constitute our "negro problem." Skin color among mulattoes is no scientific index of potential civic worth.

In brief, a state's right of suffrage should be based upon reasonable and uniform qualifications applied actually, as verbally, to all alike of whatever color (and finally sex). No ballot is free from the potentiality of great ill, unless it be cast by an honest, thrifty and intelligent hand. Appropriate educational and property qualifications uniform for all members of a state, and probably as between states, is a reasonable, just and right requirement. This is a first step, for which we already have the light of reason. Further steps must be taken more or less cautiously coincidently with accumulating scientific data. The "problem" is bright with hope; but it must be approached with charity and consistency and with scientific skill and courage.

THE EVIDENCE OF INORGANIC EVOLUTION

By SIDNEY LIEBOVITZ

WHEN we consider the marked resemblances and striking interrelations of the elements as expressed by the Periodic System, the conviction grows more and more strongly upon us that this system is the external expression of a fundamental process in nature, to which are due the general properties, as well as the individual characteristics, of the elements. On the present occasion I shall endeavor to point out that between the Periodic classification and the ordinary zoological classification, such analogies exist as tend to indicate an identity in fundamental principle. We shall then consider some of the phenomena which are at the foundation of the law of organic evolution, and here, too, we shall find among the elements conditions exactly corresponding.

A Family of the Elements Compared with a Homologous Series

Before proceeding farther, however, it is of interest to note the similarities which exist between a family of the elements and a homologous series of organic compounds. For the purpose of this comparison it is most useful to select the homologous series of fatty acids, $C_nH_{2n+1}COOH$. If we should arrange the normal acids of this series in order of molecular weight, we should find that between such a series and a family of the elements there exist certain close analogies, which are tabulated below in parallel columns.

Fatty Acids ($C_nH_{2n+1}COOH$)	*Family of the Elements*
1. There is a constant difference in molecular weight between consecutive members of 14, due to the constant group difference CH_2.	1. There is a fairly constant difference in atomic weight between consecutive elements of the same family of about 45, except between the first and second (and in some cases between the second and third), where it is about 16.
2. The first member of the series, formic acid, differs somewhat in properties from the other members of this homologous series. Thus, it manifests the characteristics of an aldehyde, reducing ammoniacal solutions of silver nitrate, etc. It has no corresponding chloride or anhydride, is readily decomposed into CO and H_2O, etc.	2. The first member in each family of the elements differs somewhat from the other members. Thus, lithium differs from the other elements of its family in forming an almost insoluble carbonate and phosphate. Oxygen, again, differs from sulphur, selenium and tellurium in that its hydride is a colorless and odorless liquid, while those of the others are gases of disagreeable odor; in that it is seldom, if ever, more than divalent; in being gaseous under ordinary conditions of temperature and pressure, etc.

3. Several compounds of this series, which theoretically may exist, are unknown. Thus, between arachidic and behenic acids there is no acid corresponding to C_{20}. Between behenic and lignoceric there is none corresponding to C_{22}. Similarly, several acids are missing between cerotic and melissic.	3. Many elements which theory predicts should exist are unknown in the Periodic Table. Thus, elements are missing between silver and gold, between cadmium and mercury, etc.
4. The vacant places are all found in the lower part of the series, *i. e.*, among the heaviest molecules.	4. The vacant places all occur in the lower part of the Periodic Table, *i. e.*, among the heaviest atoms. The first four periods are complete (excepting the manganese family). In the last three periods many empty places appear.
5. *Isomeric* forms occur in the series, *e. g.*, butyric and isobutyric, caproic and isobutyl acetic acids.	5. *Allotropic* forms occur in several of the families, *e. g.*, the various forms of phosphorus, of sulphur, of carbon.
6. In a homologous series in general, the melting points, boiling points and specific gravities change uniformly and progressively with increase in molecular weight. In this particular series (considering, as before, only the acids with normal structure) the boiling points and specific gravities show this progressive change, and the melting points do also from caprylic acid on.[1]	6. Generally speaking, the melting points, boiling points and specific gravities change progressively and uniformly in each family of the elements with increase in atomic weight.
7. The acidity decreases with increasing molecular weight.	7. The oxides of the elements become successively less acidic (or more basic) in each family with increasing atomic weight.

The above relations show that *a family of the elements possesses all the characteristics of a homologous series.* There is evidently some identity of principle in the two things compared. We know that in the one case there is in the whole series a common plan of molecular structure, the differences in the structures of the successive normal acids being due to the constant and progressive addition of the same group of atoms, CH_2; and hence it seems reasonable to suppose that there is likewise in each family a common plan of atomic structure,[2] to which are due the properties common to a family.

[1] The physical constants here used (as well as the tabulation of the acids) are those given by Leathes, "The Fats," pp. 10–11. Other authors include several acids (*e. g.*, pelargonic, undecylic) not mentioned by Leathes.

[2] For example, grouping of electrons, according to the well-known theory of J. J. Thomson.

The Arguments from Classification

The fact that the groups of organisms fall naturally into a certain classification is in itself evidence of their origin by evolution.[3] Now, the most salient characteristic of this classification is a division into groups, and a subordination of groups within groups.

> There is a breaking up into groups and sub-groups, and sub-sub-groups, which do not admit of being placed in serial order, but only in divergent and re-divergent order. . . . The Alliances are subdivided into Orders, and these into Genera, and these into Species.[4] . . . The conception finally arrived at, is, that of certain great subkingdoms, very widely divergent, each made up of classes much less widely divergent, severally containing orders still less divergent, and so on with genera and species.[5]

If we examine the characteristics of the Periodic classification, we shall find there the same peculiarities as have been observed in zoological classifications. Thus, there are the nine groups of elements, each quite distinct from the others, and each, as we have shown, very probably having a distinct plan of atomic structure common to all the members of the group. These nine groups correspond to the twelve phyla of organisms. Each group, again, is divided into two families, corresponding to the classes into which organic phyla are divided. That we have no further subdivisions corresponding to those in the organic classification is doubtless due to the circumstance that the number of elements is extremely small as compared with the number of species of animals. When we remember that even with this small number of elements, the Periodic classification presents many irregularities—as forcing into the same family elements with widely different properties (*e. g.*, the copper family); creating a group of "transitional elements" different in the principle of its arrangement from the other groups; the breaking of the periodic sequence by argon, which is greater in atomic weight than potassium, yet precedes it in the series, and by tellurium, which bears a similar relation to iodine; and the irregularities presented by the rare earths—when these facts are considered, it can scarcely be doubted that if the number of the elements were at all comparable to that of organic species, the classification of the elements would necessarily present a subdivision of group within group as extensive, perhaps, as that found among organisms. Moreover, the periodic relation would probably be largely obscured by the great number of its irregularities and contradictions.

Since the classification into which organisms are naturally arranged, of group subordinated to group, is regarded as an indication of evolution, as previously stated; the fact that a similar arrangement is found in the classification of the elements suggests (when we consider also

[3] For a detailed discussion of this point, which can not be given here for lack of space, see Spencer, "Principles of Biology," Vol. I., pp. 356–359.

[4] Spencer, *loc. cit.*, p. 297.

[5] Spencer, *loc. cit.*, p. 358.

the other evidence to be presented) that we may regard the latter system in the same light.

Another peculiarity of organic classification, which, as shown by Spencer, is important because of its indication of evolution, is the variable degree of differentiation between corresponding groups and sub-groups.

> . . . The successively subordinate classes, orders, genera and species, into which zoologists and botanists segregate animals and plants have not, in reality, those definite values conventionally given to them. There are well-marked species, and species so imperfectly defined that certain systematists regard them as varieties. Between genera, strong contrasts exist in many cases; and in other cases, contrasts so much less decided as to leave it doubtful whether they constitute generic distinctions. So, too, it is with orders and classes; in some of which there have been introduced intermediate sub-divisions having no equivalents in others. Even of the sub-kingdoms the same truth holds. The contrast between the Molluscoida and the Mollusca is far less than between the Mollusca and the Annulosa, and there are naturalists who think that the vertebrata are so much more widely separated from the other subkingdoms, than these are from one another, that the Vertebrata should have a classificatory value equal to that of all the other subkingdoms taken together.[6]

Although at first thought this peculiarity may not seem to be of much importance, yet Spencer showed, by comparison with the case of languages, in which exactly analogous characteristics are observable, and in which evolution is known to have taken place, that it is an additional indication of evolution.[7]

> If, then, the classification of organisms results in several orders of assemblages, such that assemblages of the same order are but indefinitely equivalent; and if, where evolution is known to have taken place, there have arisen assemblages between which the equivalence is similarly indefinite; there is additional reason for inferring that organisms are products of evolution.[8]

It will be evident that these observations concerning the organic classification apply with equal force to the Periodic classification. For instance, the elements of the alkaline earth family are not as sharply separated from those of the alkali family as they are from the inert gases or the halogens, and similar remarks apply to the other families. Within each group, too, the extent to which the two families comprising it differ from each other varies in the different cases. Thus, the elements of the chromium family are not as sharply distinguished from those of the oxygen family as the members of the copper family are from the alkalies. In the case of the elements, as in that of the organisms, the various groups and sub-groups differ from each other in the extent to which they are distinct from corresponding groups and sub-groups; and since in the latter instance, as we have seen, this peculiarity affords an additional indication of evolution, we have reason (when we consider

[6] Spencer, *loc. cit.*, p. 361.

[7] For a detailed discussion of this point, see "Principles of Biology," I., 361–362.

[8] Spencer, *loc. cit.*, p. 362.

also the other evidence) for so regarding it in the case of the elements also.

One other analogy demands recognition. Although, as previously stated, the phyla of organisms differ widely from each other, yet animals belonging to different phyla often show marked resemblances to each other in particular features. This phenomenon is a consequence of "the identity of plan, under the most diverse conditions of organization and habits of life (which prevails) not only among animals of the same group, but also between those of different groups."[9] For instance, regarding the affinities of the Rotifera (Phylum Trochelminthes) Parker and Haswell[10] state that

> Their general resemblance to the free-swimming larvæ of Annelids is extremely close. . . . The excretory organs recall those of Platyhelminthes, and also resemble the provisional nephridia or head-kidneys of Annulate larvæ.

Resemblances are also noted between the Class Gephyrea (Phylum Annulata) and Phoronis (Phylum Molluscoida).[11] The Crustacea (Phylum Arthropoda) "belong to the same general type of organization as the articulated worms [Phylum Annulata]."[12] Of the Phylum Mollusca it is stated that

> The Mollusca . . . form an extremely well defined phylum, none of the adult members of which approach the lower groups of animals in any marked degree. There are, however, clear indications of affinity with "worms," especially in the frequent occurrence of a trochosphere stage in development, in the presence of nephridia, and in the occurrence, in *Amphineura* and some of the lower Gastropods, of a ladder-like nervous system resembling that of some Turbellaria and of the most worm-like of Arthropods, *Peripatus*. *Rhodope*, moreover, shows certain affinities with flat worms.[13]

Similarities are also pointed out between the sponges (Phylum Porifera) and the Cœlenterata.[14]

Corresponding to these counter-resemblances in structure among organisms, we have counter-resemblances in properties among the elements. Thus, mercury (Group II.) resembles copper (Group I.) in that both form two series of compounds, monovalent and divalent respectively, both form halides insoluble in water and decomposed by light, etc. Aluminum (Group III.) is similar to chromium (Group VI.) in that the hydroxides on heating give the oxides Cr_2O_3 and Al_2O_3, respectively, in that they form no stable sulphide or carbonate, etc. Thallium (Group III.) resembles, on the one hand, lead (Group IV.) in its metallic properties, in forming a chloride with properties similar to those of lead chloride, while, on the other hand, it resembles the alka-

[9] Claus and Sedgwick, "Zoology," Vol. I., p. 54.

[10] "Zoology," Vol. I., pp. 309–310.

[11] Parker and Haswell, *loc. cit.*, p. 461. The zoological classification followed throughout is that given by these authors.

[12] Parker and Haswell, *loc. cit.*, p. 556.

[13] Parker and Haswell, *loc. cit.*, pp. 750–751.

[14] Parker and Haswell, *loc. cit.*, pp. 215–216.

lies (Group I.) in forming a hydroxide which is soluble in water and strongly alkaline in reaction.

Other examples, concerning which it is unnecessary to enter into detail, are the resemblances between phosphorus and sulphur; between beryllium and aluminum; between manganese and chromium; between boron, carbon and silicon; between gold and the platinum metals. It will be observed from the zoological examples above cited that the members of a phylum, while showing a greater or less similarity to each other, will often markedly resemble members of different phyla. The examples I have given show that a similar phenomenon is often characteristic of the elements of a family—the elements compared are in most cases similar to the other elements of the same family, while having at the same time the points of resemblance with each other described; and since the relationships referred to between distinct groups of organisms are believed to indicate a common origin, we may, perhaps, consider the analogous phenomena among the elements as of the same import.

Did space permit, other analogies might be pointed out between the Periodic and the zoological classifications; but enough has already been indicated to show that the Periodic classification possesses the main characteristic features of the zoological classification.[15] Now, the fact that these characteristics of the latter system are in themselves an indication of organic evolution suggests that the Periodic classification may be regarded in the same light, as I have already indicated. This suggestion is strengthened by the further evidence now to be considered.

The Homologue of the Embryological Evidence; the Phenomena of Radioactivity

The study of comparative embryology has brought to light certain facts which constitute important evidence of organic evolution; for many of the higher animals, in their immature forms, pass through stages in which they resemble more or less the adult forms of other animals, lower in the scale of differentiation. Moreover, animals of distinct but related species, in the progress of their development, often show marked similarities of structure. Von Baer

found that in its earliest stage, every organism has the greatest number of characters in common with all other organisms in their earliest stages; that at a stage somewhat later, its structure is like the structure displayed at corresponding phases by a less extensive multitude of organisms; that at each subsequent stage, traits are acquired which successively distinguish the developing embryo from groups of embryos that it previously resembled—thus step by step diminishing the class of embryos which it still resembles; and that thus the class of similar forms is finally narrowed to the species of which it is a member.[16]

[15] The periodicity factor in the classification of the elements will be considered later (p. 97).

[16] Von Baer, quoted by Spencer, "Principles of Biology," Vol. I., p. 365.

This statement is now known to be too broad, but is true in general principle.[17] Again,

> The embryos of the most distinct species belonging to the same class are closely similar, but become, when fully developed, widely dissimilar.[18]

To cite a few examples: The human embryo, at one stage of its development, possesses the rudiments of gill arches and gill clefts. The larvæ of most insects, no matter how diverse, pass through a worm-like stage.

> The larvæ of most crustaceans, at corresponding stages of development, closely resemble each other, however different the adults may become, and so it is with very many other animals.[19]

It is with the latter of the two embryological peculiarities mentioned above, viz., the resemblances between the embryos of different related species, that we are at present concernd.

In the radioactive transformations, we have not the advantage of witnessing a building up of elements from simple to complex forms, as in the process of embryology we observe the formation of complicated organisms from the egg. But, what is almost as good, we observe a *devolution* of elements, from complex forms to simpler. In the course of their disintegration, the three distinct elements, radium, thorium and actinium give rise to products (*i. e.*, elements) which have very similar properties.

> The substances thorium, radium and actinium exhibit many interesting points of similarity in the course of their transformation. Each gives rise to an emanation whose life is short compared with that of the primary element itself. Such experiments as have yet been made, indicate that these emanations have no definite combining properties, but belong apparently to the helium-argon group of inert gases. In each case, the emanation gives rise to a non-volatile substance which is deposited on the surface of bodies and is concentrated on the negative electrode in an electric field. The changes in these active deposits are also very similar, for each gives rise to a rayless product, followed by a product which emits all three types of rays. In each case, also, the rayless product has a longer period, or, in other words, is a more stable substance than the ray product which results from its transformation.
>
> The disintegration of the corresponding products, thorium *B*, actinium *B* and radium *C* is of a more violent character than is observed in the other products, for not only is an α particle expelled at a greater speed, but a β particle is also thrown off at great velocity. After this violent explosion within the atom, the resulting atomic system sinks into a more permanent state of equilibrium, for the succeeding products thorium *C* and actinium *C* have not so far been detected by radioactive methods, while radium *D* is transformed at a very slow rate.
>
> This similarity in the properties of the various families of products is too marked to be considered a mere coincidence, and indicates that there is some underlying law which governs the successive stages of the disintegration of all the radioelements.[20]

[17] Cf. Spencer, *loc. cit.*

[18] "Origin of Species," Vol. II., Ch. XIV.

[19] *Loc. cit.*

[20] Rutherford, "Radioactive Transformations," pp. 169–170.

Starting out, therefore, with three distinct elements, we find them going through a process of change, in the course of which all three evolve products of very similar properties. If we regard this process of disintegration as in the main a reversal of a process of evolution which once took place, *i. e.*, as a process of *devolution,* we may say, taking, for instance, Ra*G,* Th*D,* and Act *C* as the starting points, that these elements commenced a career of spontaneous change, in the course of which transition products were produced which were quite similar to each other; but ultimately three distinct elements were generated. In the case of the elements, therefore, as in that of organisms, forms which were ultimately to be more or less dissimilar, passed, in the course of their development, through stages in which they closely resembled each other.

It is still more instructive if we consider the stages in the ontogeny of various animals in *reverse order.* We should then find, taking the crustacea, for instance, as examples, that starting out with even the most diverse forms of these animals, and imagining them to go through the stages of their development in reverse order,[21] they would grow more and more similar as they approached the larval stage, and when they reached that condition, would be very much alike at corresponding stages of development; just as radium, thorium and actinium are much alike at corresponding stages in their degeneration.

Now, the significance of the embryological phenomena referred to is that these resemblances between animals of quite distinct groups are believed to indicate an ultimate common ancestry for the organisms so related; and since we have observed a condition which we may consider comparable to this among the elements, it seems probable that those radioactive elements which exhibit such close similarities as we have described as their disintegration progresses, originated by evolution from a primary simpler substance; it seems probable, that is, when taken together with the other evidences of evolution herein adduced.

Even if we disregard analogies, the fact that three distinct elements consistently show marked similarity in properties in the course of their disintegration would lead to the presumption that, if we could follow them back far enough, they might prove to be identical. This presumption is strengthened by the analogy we have considered.

It may be remarked that the changes occurring during radioactive disintegration are further similar to those which take place in ontogeny, in that in the former, as in the latter, the various stages are not permanent, but change continuously into other stages; and these changes are in both cases spontaneous, taking place without the aid of any external agency.

[21] Such a process need not be wholly imaginary, however; phenomena comparable to this are found in the instances of so-called retrograde development.

The Homologue of the Geological Record; Spectroscopic Evidence

Another source of evidence for the evolution of organisms is that derived from the study of paleontology; for the successive geological strata constitute a record of the organic forms which have successively inhabited the earth; a record which shows that in all the forms of life there is a considerable degree of continuity, and a (more or less) gradual transition from one form to another.

The homologue of this geological record in inorganic evolution is to be found in the series of stars arranged in order of decreasing temperature; for what the unknown cause of organic evolution has done for organisms, leaving the record in the geological formations, temperature (and perhaps other agencies) have done for the elements, leaving the record in stars of different heat intensities.

Lockyer has shown that the spectroscopic study of the stars, as carried on by himself and others, has revealed evidence of a very important kind for inorganic evolution. Here the results can only be briefly indicated.

As pointed out by Sir Norman Lockyer, the simplest elements appear first.

> . . . In the hottest stars we are brought in the presence of a very small number of chemical elements. As we come down from the hottest stars to the cooler ones the number of spectral lines increases, and with the number of lines the number of chemical elements. . . . In the hottest stars of all we deal with a form of hydrogen which we do not know anything about here (but which we suppose to be due to the presence of a very high temperature) hydrogen as we know it, the cleveite gases, and magnesium and calcium in forms which are difficult to get here. . . . In the stars of the next lower temperature we find the existence of these substances continued in addition to the introduction of oxygen, nitrogen and carbon. In the next cooler stars we find silicium added; in the next we note the forms of iron, titanium, copper and manganese, which we can produce at the very highest temperature available in our laboratories; and it is only when we come to stars much cooler that we find the ordinary indications of iron, calcium and manganese and other metals. All these, therefore, seem to be forms produced by the running down of temperature. As certain new forms are introduced at each stage, so certain old forms disappear.[28]

The stellar evidence, like the geological record, is incomplete, because, as stated by Lockyer, of the very small range of the photographs of stellar spectra, and also because

> It does not at all follow that the crucial lines of the various chemical substances will reveal themselves in that particular part of the spectrum which we can photograph.[29]

But whatever has been gleaned from the stellar evidence, though incomplete, is, like the information contained in the geological record, very significant in its indications of evolution.

[28] Lockyer, "Inorganic Evolution as Studied by Spectrum Analysis," p. 159.
[29] Lockyer, *loc. cit.*, p. 161.

The close analogies which we have shown to exist between the periodic and the zoological classifications would seem to point toward a fundamental identity of principle in these two systems. I have endeavored to show that there are in the inorganic world the exact homologues of some of the most important facts upon which the law of organic evolution rests, *i. e.*, the evidence of the geological record and of the embryological resemblances; to emphasize the importance of the spectroscopic evidence; and to show that the Periodic classification is in its main aspects identical in its nature with the zoological classification. These facts tend to indicate that the groups of the elements correspond to the phyla of the organisms, in being the outward expression of a process of evolution. The periodicity in the arrangement of the elements is expressive of the fact that in each family there is the same plan of atomic structure, and a gradual and progressive change in this structure as we traverse the groups from the inert gases to the halogens. That it is an imperfect relationship is shown by its numerous contradictions, already mentioned. These facts, however, harmonize entirely with the evolutionary view, for zoological classifications show just such irregularities. Moreover, according to the evolutionary view, an element need not necessarily be smaller in atomic weight than the next in the same series. The evolutionary view is entirely compatible with those phenomena, which seem to be out of harmony with the Periodic classification.

If the species of organisms were few enough and their structure simple enough, it seems likely that it would be possible to select some common characteristic which would serve as a basis of periodicity corresponding to that in the elements. Conversely, as has already been indicated, if the number of the elements were at all comparable to that of organic species, it is probable that the Periodic relation would be largely obscured by the great number of its exceptions.

Without the knowledge of the fact of organic evolution, the arrangement of animals and plants into classes, with their numerous group resemblances and counter resemblances, must have seemed a purely arbitrary one, having no basis in nature.[24] Similarly, when we consider the characters of the elements of the same families, their close resemblances to each other, and their minor resemblances to members of other families, the irregularities of the Periodic classification, etc., it is evident that we can coordinate these seemingly contradictory phenomena into a coherent whole on the basis of the evolution of the elements. The extraordinary relations disclosed by the Periodic classification are the outward and manifest signs of the process to which atoms, like organisms, owe their individual natures. The process begun in the one (the atom) continues in the other (the organism).

[24] "The propinquity of descent—the only known cause of the similarity of organic beings—is the bond, hidden as it is by various degrees of modification, which is partly revealed to us by our classification." Darwin, quoted by Spencer, "Principles of Biology," Vol. I., p. 364.

A STATISTICAL STUDY OF EMINENT WOMEN

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THE word eminent as used in this study covers the range of meaning designated by the Century Dictionary which defines the term as "high in rank, office, worth or public estimation; conspicuous, highly distinguished." According to the same authority, the word is rarely used in a bad sense. Dr. Francis Galton,[1] who made the first statistical study of distinguished men, defined his use of eminent thus:

> When I speak of an eminent man, I mean one who has achieved a position that is attained by only 250 persons in each million of men, or by one person in each 4,000.

While my selection is closer, mathematically, than Galton's, among the 868 women whom I have designated as eminent, some are included because of circumstances over which they had no control, such as great beauty, or congenital misfortune. Many were born to their positions; to others is due but little credit for the fact that they married men sufficiently eminent to accord them a place in history. Some led spectacular lives and were notorious rather than meritorious. Many of them were women of unusual intellectual ability and were eminent in the ordinary connotation of the term. More or less biographical data are at command concerning these 868 women, and to the extent that reputation may be considered a just index of ability, they are entitled to a place in a catalogue of the distinguished of earth.

In selecting the group I have followed precisely the objective method devised by Professor J. McKeen Cattell[2] in his "Statistical Study of Eminent Men." My method, in detail, was as follows: I went through the Lippincott Biographical Dictionary, the Americana, Nouveau La Rousse, Brockhaus's Konversations-Lexikon, Meyer's Konversations-Lexikon and the Encyclopædia Britannica and noted the name of every woman mentioned in each. I retained for my list the name of every woman noted in any three out of the six encyclopedias or dictionaries. My original intention was to eliminate from the lower end of the group until I had 1,000, a convenient and sufficiently large number with which to work. But when the twenty-three Biblical characters were excluded, the entire number was only 868. It is a sad commentary on the sex that from the dawn of history to the present day less than one thousand women have accomplished anything that

[1] "Hereditary Genius," p. 10, 1869.

[2] "A Statistical Study of Eminent Men," POP. SCI. MO., Vol. 62, p. 359, 1903.

history has recorded as worth while. One can not evade the question, is woman innately so inferior to man, or has the attitude of civilization been to close the avenues of eminence against her?

When the list of names was completed, the amount of space accorded the women by the different encyclopedias was reduced to a common standard, and the names arranged in order of merit.

According to our standard of measurement Mary Stuart is the most eminent woman of history. She has no close competitor. Queen Victoria is the most recent of the preeminently gifted women, and therefore has a large probable error of position. George Sand is the most distinguished literary woman, and we may say that the chances are even that her position as fifth in the order of merit is correctly determined. The most eminent woman of American birth is Mrs. Stowe, who ranks twentieth. Had additional or different encyclopedias been used in compiling the list, the chances are one to one that her position would be between 17 and 21.

It must be borne in mind that had other sources been used in selecting the eminent women, the position of certain ones might have shifted more or less. However, we must concede that the women who are ranked in this list as the most eminent are the ones most familiar to us in literature and history, and they unquestionably deserve their position. The twenty preeminently gifted women of history are Mary Stuart, Jeanne d'Arc, Victoria of England, Elizabeth of England, George Sand, Madame de Staël, Catherine II. of Russia, Maria Theresa, Marie Antoinette, Anne of England, Madame de Sévigné, Mary I. of England, George Eliot, Christina of Sweden, Elizabeth Barrett Browning, Madame de Maintenon, Josephine of France, Catherine de Medici, Cleopatra and Harriet Beecher Stowe.[8]

A list of this sort makes possible comparisons which are not ordinarily evident and could not otherwise be made, and the known probable error makes it possible to determine within what limits the comparisons are true. Charlotte Brontë and Charlotte Corday seemingly have nothing in common, yet their respective numbers in order of merit are 21 and 22. Marie Brinvilliers, whose mania for poisoning makes it impossible to classify her as anything but a criminal, just precedes Geneviève, the patron saint of Paris. Joanna Baillie, the poet; Mrs. Siddons, the actress, and Beatrice Cenci, whose beauty and tragic fate have been preserved for us in the colors of Guido Reni and in the lines of Shelley, are numbered 89, 90 and 91, respectively.

The range of eminence covered by these 868 women is wide. Mary Stuart, with 607.67 lines, is more than one hundred and eighty-eight

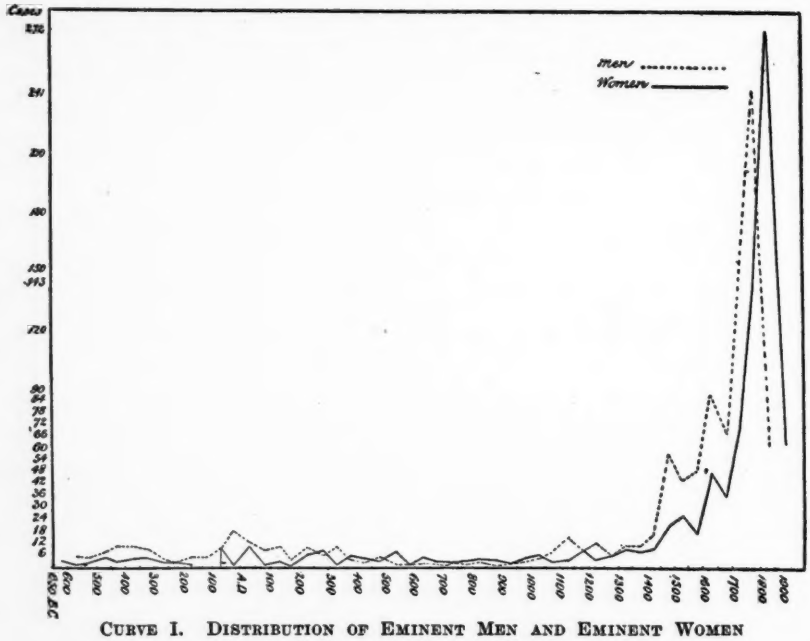
[8] The complete list of the 868 eminent women together with detailed and technical discussion of the data will be found in a thesis accepted for the degree of doctor of philosophy by the department of psychology, Columbia University, to be published in *Archives of Psychology* (The Science Press, New York).

times as eminent as Constance Bonaparte with 3.23 lines. There are forty-nine women who are given one hundred or more lines in the encyclopedias, and there are twenty-seven that are given less than ten lines. The average amount of space accorded is 43.2 lines.

This group of eminent women is spread over a long period of time. From the seventh century before Christ to the nineteenth century after Christ, inclusive, the light of feminine genius has never been extinguished, though sometimes it has burned but dimly. Beginning with three cases in the seventh century before Christ, we observe that the Golden Age of Greece records a rise in the curve. Who knows but that her women were potentially as great as her men, and if Plato's theory regarding the education of women had been universally applied, the curve might not have risen higher? In the second century before Christ, Cornelia, the mother of the Gracchi, is the sole representative. The period of Roman supremacy is clearly depicted, as is also that of the religious persecutions in the third century, eleven of the fourteen representatives of that century being martyrs. Through the Dark Ages, the level of the curve remains almost stationary. There is a little rise in the twelfth century, but a subsequent fall in the thirteenth. This, however, is insignificant because of the few cases. The curve rises considerably in the fourteenth century, almost doubles its height in the fifteenth, and does not drop again. The eighteenth century produces 213 cases, or 24.5 per cent., of the eminent women of history. We must bear in mind the fact that the records for the nineteenth century are neither complete nor accurate. The youngest woman on my list was born in 1880, therefore one fifth of the century is not represented, and one half of it but partially. Ability in woman is more readily and willingly recognized at the present time than formerly, so names of women whose reputation for eminence may not prove enduring may be included in the nineteenth-century group. On the other hand, the eminence of a large group of women is now in the process of making, and subsequent biographers may accord them a more important place than their contemporaries. While the figures for this last century are in no respect accurate, they are in many respects interesting. The century furnished 335 cases, or 38.5 per cent., of the total number of eminent women. Sixty-three per cent. of the eminent women of history were born in the last two centuries. If we were able to compare the number of cases in each century with the population of that period, as Professor Cattell pointed out in his study, the curve would, in some respects, be different from this one. For a partial comparison we have used a modified form of the table of growth of population given by Mulhall[4] and have found that while the number of eminent women produced by England, France, Russia, Austria, Italy, Spain, Germany

[4] "Dictionary of Statistics," 4th edition, 1898, p. 441.

and the United States increased from 28 in the fifteenth century to 187 in the eighteenth century, the ratio of eminent women per ten million of population also increased from 6.1 to 15.3 in the same period. Those who refuse to lose faith in woman's ability may find encouragement in the fact that the gain of the rate per ten million of population of the sixteenth century over the fifteenth was 19.6 per cent.; of the seventeenth over the sixteenth, 27.3 per cent.; of the eighteenth over the seventeenth, 64.5. An interesting conjecture is whether the complete record for the nineteenth century will give a gain per cent. over that of the eighteenth correlative with the increased social and educational advantages which women have attained.



CURVE I. DISTRIBUTION OF EMINENT MEN AND EMINENT WOMEN IN PERIODS OF HALF CENTURIES.

Curve I. shows the distribution of distinguished women and distinguished men in periods of half centuries, the figures for the men being taken from the previously quoted article by Professor Cattell. In comparing the distribution of eminent men and eminent women through the centuries, three facts must be borne in mind. (1) One thousand eminent men were studied, and only eight hundred and sixty-eight women, so the male curve might be expected at all points to rise higher than the female. (2) The eminent men represent a much higher degree of selection than the women. (3) The study of eminent men was made in 1903 and no living persons were included. These facts do not, however, make it impossible for us to note certain similarities and dissimilarities.

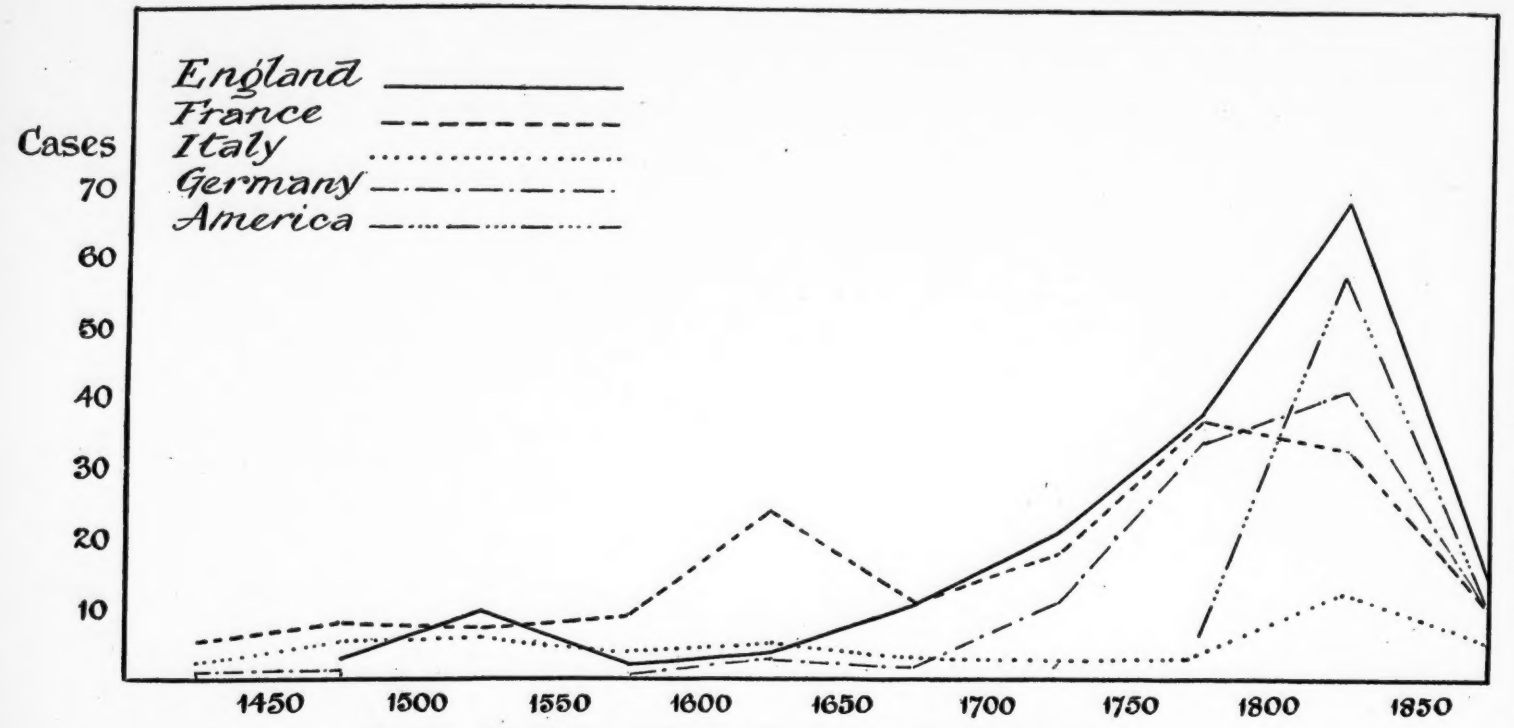
The curves are similar during the period of Greek supremacy. The male curve for the Roman period is much more regular than the female. The last half century of the pre-Christian era which produced more eminent Roman men than any other, produced but one eminent Roman woman. The lines cross for the first time in the second half of the third century after Christ. From the sixth to the eleventh century the number of women equals or exceeds the number of men. With few exceptions, the eminent women of these centuries are sovereigns, abbesses and saints, or belong to the groups "Marriage" and "Birth." If the eminent women were selected as rigidly as the eminent men, the position of the curves through these centuries would undoubtedly be reversed. Of the later period, Professor Cattell writes,

> In our curve there are three noticeable breaks. . . . Thus, in the fourteenth century there was a pause followed by a gradual improvement and an extraordinary fruition at the end of the fifteenth century. . . . There was then a pause in progress until a century later England and France took the lead. . . . The latter part of the seventeenth century was a sterile period, followed by a revival culminating in the French Revolution.

If we except the first half of the sixteenth century, when the male curve fell and the female rose, the identical words might have been written of the eminent women. Whatever the factors in these centuries that cooperated to produce genius, they were effective in both sexes, though to a lesser degree in the one than in the other.

The 868 eminent women are natives of forty-two different nations. England has furnished eight more distinguished women than France. Germany ranks third with 114; America, only two centuries old, is fourth. Italy produced 60, Rome 41, Austria 24, and Spain 23, eminent women. Russia claims 20, Sweden 16, Greece 15 and Scotland 14. Twelve of the eminent women belong to the Byzantine Empire, 11 to Holland, and 9 to Ireland. Twenty-seven nations each produced fewer than ten eminent women.

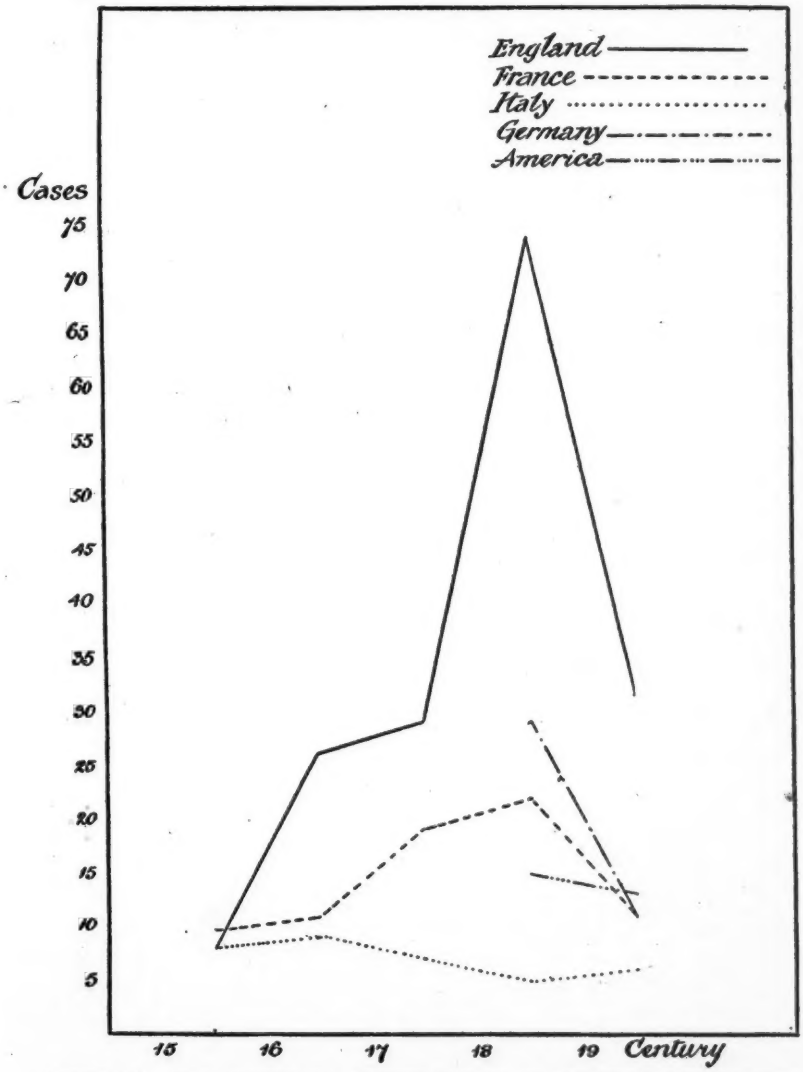
The relative number of women of ability produced by England, France, Germany, America and Italy, at different periods, is shown in Curve II. In the fifteenth century, France and Italy were leading in the number of eminent women. By the beginning of the sixteenth century France was declining and England had surpassed them both. But England had a subsequent fall, and France a rapid rise, at the beginning of the seventeenth century. Later in the century, France declined again; England gained; the German curve rose rapidly; and the Italian remained very low. Of the five modern nations which have contributed the largest number of eminent women, France is the only one for whom the incomplete records of the nineteenth century show a decline in the number of eminent women over the eighteenth century. We quote as peculiarly applicable what Professor Cattell said regarding the eminent men:



CURVE II. THE NUMBERS OF EMINENT WOMEN OF DIFFERENT NATIONALITIES.

The French Revolution brought into prominence many men not truly great, and the position then attained by France is not held in the nineteenth century.

The figures for the last century reveal a third period of Italian activity, chiefly in music and literature. In so far as the data for the nineteenth century are reliable, America gives greater promise for the immediate future than any other nation.



..Curve III. The Number of Eminent Women of Different Nationalities on the Basis of Population.

Curve III., which shows the record of these same five nations through the same centuries on the basis of population, is, in one sense, more significant. From the point of view of the number of eminent

women per ten million of population, France is not the only nation whose nineteenth century ratio fails to equal that of the eighteenth. Germany, and especially England, have failed signally in this respect. Italy is the only one of the five modern nations which at present shows a gain in ratio of eminent women according to population, in the last century over the previous one. She seems to be rising out of the trough of a curve, the crest of which was reached in her sixteenth century Renaissance. These figures emphasize the promising situation in America. In another half century, it will undoubtedly be seen that while our population increased from 3,930,000 in 1790 to 50,155,783 in 1880, there was a corresponding increase in the number of American women of ability per ten million of population. No more vital problem in connection with the social and educational life of woman could be propounded than the one revealed by these curves. Is the racial difference an important factor, or must one look to the social conditions and educational opportunities of the time for an explanation? Why is it that England, starting in the fifteenth century with the same ratio as Italy (8 eminent women per ten million of population) should rise in the eighteenth century to 73, while Italy fell to 5? Or, why has the English curve, which started lower than the French, and equal with the Italian, towered, since the sixteenth century, so far above the remaining four? How explain the fact that while France was so prominent in the eyes of the world in the eighteenth century, and her women had unusual opportunity to come into public notice, the number of eminent women on the basis of population being produced by Germany, and especially by England, was far in advance of the number being produced by France? In America, the youngest of the five nations, what is there to explain our present position above Italy, Germany and France, and second only to England? Or, to be more insistent, what would a comparison of modern English and American conditions reveal that would determine that the latter should be second, instead of first, in the ratio of eminent women per ten million of population?

Accustomed as we are to thinking of the sphere of woman as a limited one, it is interesting to note that the 868 women became eminent in twenty-nine lines of activity, if some of the following classifications can be so designated. The distribution is as follows: Literature 337; Marriage 87; Religion 64; Sovereign 59; Actress 56; Music 49; Birth 39; Mistress 29; Scholar 20; Political Influence or Ability 19; Artist 17; Philanthropy 12; Tragic Fate 11; Heroine 10; Motherhood 10; Reformer 9; Dancer 6; Immortalized in Literature 6; Patron of Learning 6; Beauty 6; Educator 3; Revolutionist 2; Misfortune 2; Traveler 2; Adventuress 2; Physician 2; Fortune Teller 1; Conjugal Devotion 1; Criminal 1.

Of the entire group of women 38.8 per cent. won their eminence by

the use of the pen. It is probable that woman has had more opportunity in literature than in any other line of work. Her actions have been restricted in various degrees at different times, and in different localities, and, to a certain extent, her thought has been regulated. It is, undoubtedly, her innate right to reign supreme over her feelings. An analysis of the group of 337 writers shows a large per cent. of feminine literature to be of an emotional or imaginative nature. If, to the group of writers we add the women classed under "Religion," the actresses and the musicians, we note that we have 506, or 58.2 per cent., of the entire group of eminent women before we reach the small group of scholars who have exercised the power of reason. Add to this the artists and dancers as further illustrations of emotional activity, and we still see that the common concept of a woman as a creature of feeling rather than a creature of reason may not be without foundation. If this conception is just, our classification tends to show that when woman has attained eminence, it has not been in spite of her femininity, but rather because of it.

As remote as the seventh century before Christ women became eminent in literature. This early work is poetry and undoubtedly represents the outburst of genius rather than the result of training. In the early centuries, a woman might be born to eminence, and in a few instances she was allowed to govern, but a large percentage of the names that have come down to us as late as the sixteenth century are those of women who were wives of men more distinguished than themselves. The Christian religion made a strong appeal to womanhood, and no century has been without its representative in this field. In the group of 64 eminent women classed under "Religion" in our study, five were founders of sects known respectively as Christian Science, the Buchanites, the Southcottians, the Countess of Huntingdon's Connection, and the Shakers. In addition, Saint Clara founded the Franciscan Order of Nuns; Saint Theresa, the Barefooted Carmelites; Angela Merici, the Ursuline Order; and Jeanne Chantal, the Order of Visitation. Sixteen, or one fourth of the group, suffered martyrdom. Motherhood, heroism and beauty occur occasionally without reference to time or nationality. Actresses date only from the seventeenth century, and musicians from the eighteenth. The reformers, dancers, educators, revolutionists, travelers and physicians are products of the last two centuries. For those who are interested in the problem of the modern woman the record for the nineteenth century ought to be of interest. Of the 335 women of the century, 184 are writers. The stage has been the stepping stone to eminence for more than eight times as many women as became noted because of their religion. If, however, we allow a broad interpretation of religion to include social service, and thus combine the groups "Reformers" and "Philanthro-

pists" with the group "Religion," the ratio is 33 to 19. Forty-three of the eminent women of the century are musicians; eight are artists. There are five scholars. Of the seven women born to eminence in the last century, five are near relatives of Napoleon I., the most eminent man of history.

Of the 337 writers, 108 were English, 58 German, 56 French and 41 American. Rome furnished 10 of the Christian martyrs. Aside from Rome, England, France and Italy have produced most of the saints of history. Seven of the great queens were Spanish, and 7 Russian. Twenty-one of the 56 actresses were French, and 13 English. It has been in France more than in any other country that women have been born to greatness. Only seven nations are represented in the group "Mistresses," France producing 16 of the 29. England, Germany and Italy each claim 3 scholars; America has one, the astronomer, Maria Mitchell. French women have become eminent through politics more than the women of any other nation. The artists are scattered, France and Italy leading with 3 each. Germany and Italy have led in musicians with 9 each. England has led in philanthropy as the work of woman. The social reformers comprise the largest group, which belongs entirely to one nation. These 9 women were Americans.

Although 38.8 per cent. of the entire group of women became eminent in literature, it does not follow that in this line of work they attained the highest degree of eminence. The following table shows the average number of lives given to the different groups. The averages may be considered as indices of merit for the various occupations. The number of cases on which the average is based is indicated in each instance. The results show very clearly that it has been as sovereigns that women have become the most eminent. Second in rank, but reduced to almost one half the degree of distinction attained by the sovereigns is the group of politicians. Motherhood, based on fewer cases than either of the two previous groups, ranks third. This group of mothers does not include women, who, besides having eminent sons or daughters, were themselves distinguished in some line of activity. Such women fall in the several groups in which they achieved fame. This group is comprised of those women whose only claim to eminence is their motherhood. Undoubtedly, they were very capable women. Typical illustrations are Saint Monica, the mother of Saint Augustine, and Lætitia Bonaparte, the mother of the first emperor. The mistresses—which group includes the early Greek courtesans—rank high, and justly so. Our standards have changed, and while our moral sense may be offended at seeing twenty-nine women so classified, we are led to believe that, in many instances, these women, whatever their morals, were intellectually among the most capable of their sex. Restricted by

the social customs of their times, they found in this relation an opportunity to meet and associate with men of their own intellectual power. Were it not so, it scarcely seems probable that mere beauty or pleasing personality which fascinated some weak-minded king could have been sufficient reason for the high degree of merit which history has accorded them.

The artists rank comparatively low in merit. However, if we consider the groups of activity in which women have actually done things —attained their eminence by genuine labor—of the groups sufficiently large in size to expect accuracy in results, we note that the artists rank higher than the actresses, writers or musicians. A possible explanation of the very low degree of merit accorded the musicians is the fact that 43 of the 49 belong to the nineteenth century, and of these 43, 20 are living at the present time, so their merit is not yet accurately determined.

The merit of George Sand, Madame de Staël, Madame de Sévigné, George Eliot, Mrs. Browning, Mrs. Stowe and Charlotte Brontë is not sufficient, when grouped with so many writers of less ability, to bring the average for the group "Literature" to more than 29.74.

INDEX OF MERIT FOR OCCUPATIONS

	Average No. of Lines	No. Cases on which Average is Based
Sovereign	112.10	59
Political influence	62.13	19
Motherhood	46.14	10
Mistress	46.09	29
Beauty	44.62	6
Religion	43.58	64
Tragic fate	42.83	11
Marriage	38.09	87
Patron of learning	37.60	6
Heroine	35.46	10
Scholar	35.35	20
Artist	34.54	17
Reformer	32.29	9
Actress	32.02	56
Literature	29.74	337
Immortalized in literature	29.30	6
Music	27.46	49
Birth	27.45	39

Considerable interest always attaches to the wives of eminent men, and to the husbands of eminent women. Personally, we do not believe that, with rational people, love is blind, hence it seems that a study of the marriage relations of this group of eminent women ought to reveal information, not only interesting, but valuable in throwing light on certain social and psychological problems. We must remember

in this connection, however, that one current definition of genius does not always grant the rationality of the individual. Only lawful marriages are considered in this study; *liaisons* are not recognized. Four morganatic unions are included. Owing to lack of information, ninety-three eminent women are unclassified as either married or unmarried.

One hundred and forty-two, or 16.3 per cent., of the entire number of women of ability, have not married. Of this group, 72.5 per cent. were born in the last two centuries, and 49.2 per cent. of the unmarried eminent women of history belong to the nineteenth century. There is, of course, the possibility that some of our contemporary women of distinction may yet marry, and thus reduce this ratio. England and America have produced 59.8 per cent. of the unmarried women of ability. The former country has twenty-one more unmarried eminent women than the latter, but the figures for America are the more significant, since in terms of per cent. they mean, that of the total number of distinguished women produced by England, 29.7 per cent. of them have not married; whereas, in America, the ratio is 42.6 per cent. It is a pertinent question whether our women realize that in attaining eminence nearly one half the number sacrifice their own homes and families. Our figures do not show that any one line of activity has appealed particularly to the unmarried group. Neither were they, in their freedom from the duties and responsibilities of wifehood and motherhood, able to attain a higher degree of eminence than the married women; nor was their average length of life found to be longer.

Two hundred and fifty-nine of the distinguished women married men sufficiently eminent to be recorded in three or more of the six encyclopedias used in collecting the list of women. The number of lines accorded these husbands was counted and submitted to the same system of standardization as that used for the women. Napoleon I., Peter the Great, Henry IV. of France, Philip II. of Spain, Mark Antony, Nero, Philip II. of France, Claudius, Louis XII. of France, Ptolemy I. and Chilperic I. were each married to two of the eminent women. Five of the wives of Henry VIII. of England are included in our list of distinguished women. On the other hand, twenty-two of the women married more than one husband sufficiently eminent to fall within our classification.

Our knowledge of the relative eminence of the husbands and wives makes possible some interesting comparisons. Eight of the husbands, namely, Napoleon I., Mohammed, Julius Cæsar, Martin Luther, Alexander the Great, Frederick the Great, Socrates and Napoleon III. are more eminent than Mary Stuart, the most eminent woman of history. Jeanne d'Arc and Queen Victoria are less eminent than the poet Shelley, but more eminent than the first Roman emperor, Augustus Cæsar. Mary I. of England is of equal eminence with Philip IV. of France.

Rosa Bonheur and Antoninus Pius are accorded the same number of lines. Thirteen eminent women are less distinguished than King Hakon of Norway, the least eminent of the husbands. We have here an exact means for telling whether Robert Browning is more or less eminent than his gifted wife, and how much; whether the joint sovereigns of England, William and Mary, are equally distinguished; whether Cornelia, the mother, and Tiberius Sempronius, the father, of the Gracchi are equally famous; and whether Otto Goldschmidt is more or less distinguished than Jenny Lind.

The two hundred and fifty-nine eminent women who married men of sufficient distinction to come within our criterion of eminence were natives of thirty-one different nations, but France, England, Germany and Rome produced the larger number of them. Julia Ward Howe, Julia Marlowe and Elizabeth Drew Stoddard are the only noteworthy American women who married husbands sufficiently eminent to be included in our list.

The average age at which eminent women have married (based on 459 cases) is 23.4 years. This means, in each instance, the age when married for the first time. Three of the women were married under ten years; thirty were married before they were fifteen; five married later than fifty. The youngest bride was Joan of Naples, who at the age of six was married to Andrew, Prince of Hungary. The oldest bride was Angela Burdette-Coutts, who at sixty-seven married Mr. Ashmead-Bartlett.

The following table shows a fairly regular tendency through the centuries to postpone marriage from 16.2 years in the twelfth century to 26.2 years in the nineteenth. The range of age of brides has also varied, particularly in the maximum limit. Through the twelfth, thirteenth, fourteenth and fifteenth centuries no eminent woman was married later than thirty. In the last four centuries the maximum limit has varied from forty-three to sixty-seven. In other words, we may say that the maximum age of marriage during the last four centuries (nineteenth, eighteenth, seventeenth, sixteenth) averaged 53.3 years; for the preceding four centuries (fifteenth, fourteenth, thirteenth, twelfth) it averaged 25.8 years.

AGE AT MARRIAGE IN DIFFERENT CENTURIES

Century	Average Age at Marriage	No. of Cases on which Average is Based	Range of Age of Brides, Years
19	26.2	189	15–67
18	23.1	127	13–53
17	20.0	50	13–43
16	21.7	28	12–50
15	17.6	20	13–26
14	13.8	11	6–18
13	16.6	5	12–29
12	16.2	5	8–30

There is considerable variation in the average age at which women of ability have married in different nations. Considering only those countries for which we have record of nine or more cases, it has been found that the average age at which American women of ability marry is 27.7 years, which is 9.3 years later than the average age at which Russian women of eminence marry. Distinguished women of English birth marry three years younger than American women, but 1.8 years later than German, and 3.5 years later than French women of ability. The average age at marriage of Italian and French eminent women is practically the same (21.3 and 21.2 years, respectively).

The average age at which eminent women engaged in thirteen different activities married is shown in the following table. Though we have record of only five reformers we feel fairly confident that the group is justly placed. Only a few American women of the nineteenth century have achieved eminence as social reformers; but American women of ability marry later than those of any other nation, and the average age at marriage in the nineteenth century is later than in any other period of history. The fact that musicians marry 3.1 years later than actresses, and 4.4 years later than artists, seems to indicate that, in many instances, marriage was postponed until a musical reputation had been won. The women who inherited or wedded their right to eminence, that is, the members of the groups "Marriage," "Sovereign" and "Birth" married earlier; where the cases are sufficiently numerous to justify a conclusion it seems that the women who have won by personal effort their right to distinction—the actresses, writers, musicians and reformers—married several years later.

AGE AT MARRIAGE BY OCCUPATION

	Average Age at Marriage	No. Cases on which Average is Based
Reformer	27.4	5
Music	26.7	35
Mistress	26.4	7
Literature	25.7	180
Actress	23.6	32
Religion	22.4	14
Artist	22.3	6
Scholar	21.3	8
Political influence	19.5	14
Mother	19.3	6
Birth	19.3	24
Sovereign	18.9	40
Marriage	18.8	62

Of the eminent women, 520 are known to have married once, 89 married twice, 21 married three times, and Catherine Parr, Joan I. of Naples, Jacqueline of Holland, Lola Montez and Zoe II. were each

married four times. Though the numbers are small, it is of interest to note that 42 per cent. of the group of women who became eminent because of political influence or ability were married more than once. Of the total group of musicians, 30.6 per cent. had more than one husband.

Eminent women have not, on the whole, made particularly successful wives, since 11.6 per cent. of the 781 unions of which we have record have ended in separation or divorce. 36 of the 91 cases of dissolution occurred in families where both husband and wife were famous.

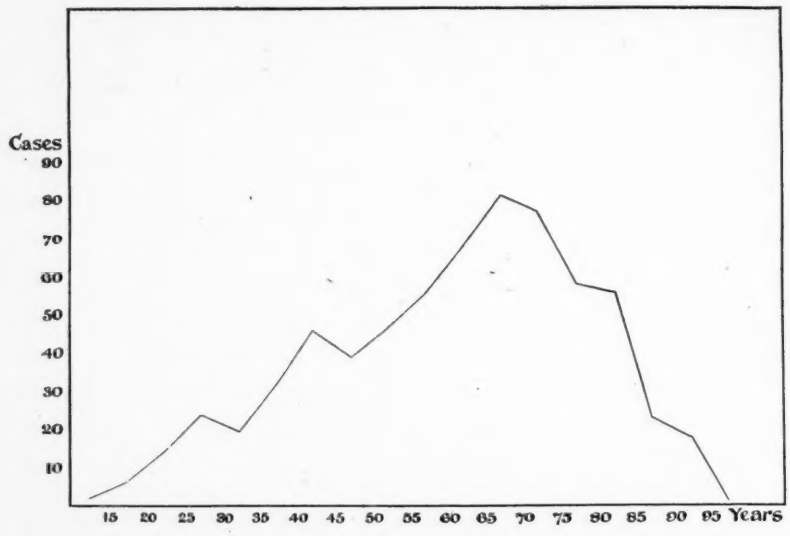
Divorces have been most frequent among distinguished women of German birth. It is barely posible that we have found these results, not because of actual conditions, but because the German encyclopedias are more inclined to give details of domestic life than are those of other nations. The German divorce rate, however, is known to be high. Though much is said about the alarming increase of the rate of divorce in America, it does not hold in the case of eminent women (3 cases).

I have tried to discover whether divorce has been more or less frequent when the husband and wife have been engaged in the same occupation than when their interests were more or less diverse. I hoped to learn whether a singer has been more apt to run into matrimonial shipwreck if she married a composer than if she chose a lawyer for a husband. Has it been safer for a literary woman to marry a scholar or a banker? My figures are not very conclusive, owing to the small number of cases in each occupation, but where a conclusion is warranted, our table tends to show that artists and musicians are safer matrimonially when married to men whose interests are in fields different from their own. In other words, it is better when the husband and wife are not both engaged in an activity which is controlled by temperament and inspiration rather than by reason. In the case of actresses, the percentage of divorce is just the same when the husband is an actor as when he is engaged in some other occupation. With writers, the divorce rate is slightly smaller when the husband is a literary man.

Royal divorces are recorded as remote as the fourth century before Christ. Eminent women not of aristocratic birth have obtained divorces only in the last three centuries.

It has been impossible to discover at what age these women became eminent, but in 670 cases I have been able to ascertain the age at death. Curve IV. represents the age distribution graphically. Both ends of the curve are interesting. Nine women died before they were twenty; nineteen lived to be over ninety. The average length of life is 60.8 years. The slight rise in the curve for eminent women in the twenties, and again in the forties, tends to confirm Galton's conclusion that "among the gifted men there is a small class who have weak and

excitable constitutions, who are destined to early death, but that the remainder consists of men likely to enjoy a vigorous old age." [5] Our cases are so few that we can not lay stress on these periods as being particularly precarious in the case of eminent women.



CURVE IV. DISTRIBUTION OF AGES OF EMINENT WOMEN AT DEATH.

In spite of the fact that in a number of instances the data are too meager to be reliable, it seemed worth while to compute the average age of the eminent women for the different centuries. For the first two centuries after Christ I have only three cases each, but these tend to show that in this remote period, eminent women died early. The martyr's block has left its record in the third century, the average, based on seven cases, being only 28.2 years. Saint Helena escaped a violent death and lived to be 77. If her case were excluded, the average age for the century would be 20.1 years. During the fifth, sixth and seventh centuries the average length of life seems to have been longer. For the remainder of the Middle Ages the figures are so meager as to render them valueless, but from the fourteenth century the numbers are sufficiently large to at least represent a tendency. The average age at death in the case of eminent women of the fourteenth century was 48.7 years; in the fifteenth century, 49.3 years; in the sixteenth century, 49.8 years; in the seventeenth century the average was increased to 60.6 years; in the eighteenth century it was 64.1 years; in the nineteenth century, 62.7 years. This, however, is not a final figure for those of this century who are to be the longest lived and who will tend to increase this average are yet living. It is probable that these aver-

[5] "Hereditary Genius," p. 332, 1869.

ages have no special relation to eminent women, but they seem to show that the advancement of civilization with the increased knowledge of hygiene and the art of living, together with the modern development of medicine and surgery, have cooperated to make it more probable that the days of woman will be prolonged to three score years and ten.

It is of interest to note that the women who have been engaged in social service, the reformers and philanthropists, were the longest lived. The average age of the artists is 66.7 years, and of the actresses 64.5 years. In addition to these, the writers, scholars, politicians and mothers all lived to an average age exceeding that for the entire group. The musicians average 58.4 years; those famous by birth, as sovereigns, mistresses, in religion and by marriage all average less than the group average.

American women of ability are noticeably longer lived than those of any other nation. While this average results in part from the fact that we are a young nation and hence our figures are not affected by early deaths in remoter centuries, it also speaks well for the physical vigor of American women, for our respect for sanitation, and for the skill of American physicians and surgeons. In addition to the American women of eminence, those of Scotland, Germany, Austria and England have lived to more than 60.8 years, the average for the entire group. The women of the Byzantine Empire, of France, Sweden, Holland, Italy, Ireland, Spain, Russia and Rome have failed to attain this average.

Sixty-two, or 7 per cent., of the eminent women of history are known to have suffered violent or unnatural deaths. This bloody chapter began with the tragic death of the Roman girl, Lucretia, in the sixth century before Christ and nineteen centuries are represented in the record. Nineteen of these sixty-two women were Romans; France contributed eight, leading the modern nations in this respect. Sovereigns, or the wives of sovereigns, have been the most frequent victims.

Seventy-two, or 33.1 per cent., of the 217 fathers of the eminent women regarding whom we have been able to collect information, belonged to the so-called learned professions—medicine, teaching, law and the ministry. Our figures tend to show that an eminent daughter has been more apt than not to become distinguished in a line of work similar to that of her father. For example, in the case of sixteen fathers who were musicians, nine of their daughters who achieved fame were also musicians, and two were in the closely related field of acting. Of fifteen fathers who were literary men, fourteen of their eminent daughters were also writers. In considering the similarity of occupation between eminent daughter and father, women of aristocratic extraction have been excluded.

Regarding the cases of relationship that were found to exist be-

tween the eminent women not of noble birth, eighteen of the thirty-eight instances are in the first generation between sister and sister. Fifteen cases occur in the second generation, eight between mother and daughter, and seven between aunt and niece. In the third generation, there are four cases, and in the fifth generation, one case. The figures show a marked tendency for the woman in the younger generation to become eminent in the same, or closely allied line of activity as that in which her eminent relative won distinction.

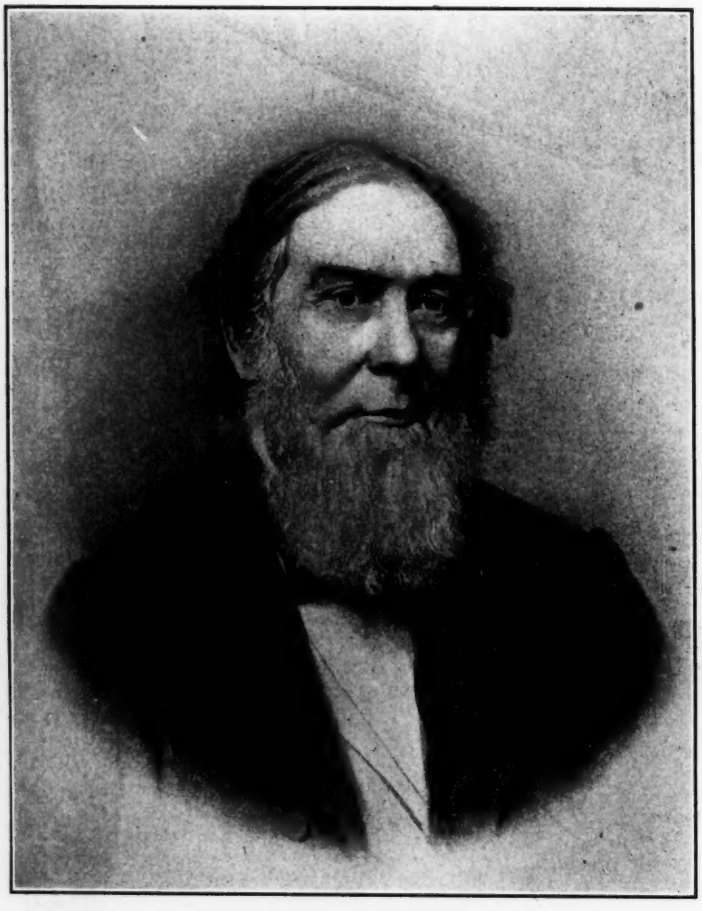
An interesting and suggestive group for consideration is that of the contemporary eminent women. Of these there are 107. The first item of interest is that this group is so large. 12.3 per cent. of the eminent women of history are living at the time this study is made. It required over twenty-five hundred years to produce the remaining 87.7 per cent. This group represents nineteen nationalities, and twelve lines of activity. England, with twenty-two cases, leads in the number of distinguished women of the present generation; Germany and America each claim eighteen; France has twelve, and Italy seven. Austria has six; Sweden, four; Holland, Spain and Hungary, three each; Russia and Poland, two each; and Denmark, Canada, Venezuela, Belgium, Roumania, Scotland and Norway, one each. Canada and Venezuela are represented for the first time in history in the present generation.

In the Old World it is probable that woman will always be able to acquire fame with the wedding ring, and to reign as a sovereign, thus being assured a place in history. If we eliminate those two groups, the fields in which contemporary women are acquiring eminence are, in spite of greater social and educational advantages, and freedom from restriction in many lines, practically limited to three. Fifty-five are writers, twenty are musicians and fourteen are actresses. We wish that we might not have found Jane Addams working alone in the great field of social reform, and that Madame Curie might not have been the only scientist of her generation. In America, where women enjoy greater freedom than in any other part of the globe, there is little evidence of any special results of these advantages. The nation and generation are proud of the achievements of Helen Keller, but one expects that our great educational institutions would produce feminine scholars and teachers of great ability. Possibly, they are in our midst, but like the prophets of old, are without honor in their own generation as well as in their own country.

In order to do justice to this group of eminent women a number of lines of inquiry not yet touched upon deserve to be investigated. Perhaps the most important of these is a study of their children. A knowledge of the number of children born to or reared to maturity by these 634 wives will determine whether in attaining eminence they

sacrificed the function universally accepted as the noblest. It may, perhaps, be shown that whatever they did to perpetuate themselves in history was not at the expense of, but rather in addition to the duties of motherhood. Some correlation, either positive or negative, may be revealed between the size of family and the degree of eminence attained. The number of children who became famous is also of great importance from the standpoint of heredity, and it will at least be interesting to know whether more of them were sons or daughters, and how their fields of life activity agreed with or differed from that of their mothers.

A study of the state of health and cause of death may reveal much needed information as to whether female genius differs physically or physiologically from others of her sex. The relative variability of the sexes is a matter of prime importance in a study of female ability, as is also the question of psychical sex differences. Thorough examination of the social and educational environment of this group of eminent women is not only desirable, but essential in understanding them as the historical representatives of their time. The relative productivity of the aristocracy, and a careful social classification ought to be made. Women have not always had the advantages they now enjoy. It is not probable that the female voice has varied in sweetness through the ages, yet it was not until the eighteenth century that we have record of a noted songstress. Have we any reason to believe that when women have gained all the rights and privileges for which they now clamor that any significant results will follow? Is there a biological limitation which says to the female, "Thus far shalt thou go and no farther"? While we may never be able to settle these questions definitely, a just and thorough consideration of all the points of approach will, we trust, enable us to answer with some degree of certainty the question which we propounded at the beginning of our study, and which has haunted us throughout the research, namely, has innate inferiority been the reason for the small number of eminent women, or has civilization never yet allowed them an opportunity to develop their innate powers and possibilities?



A. D. Bache

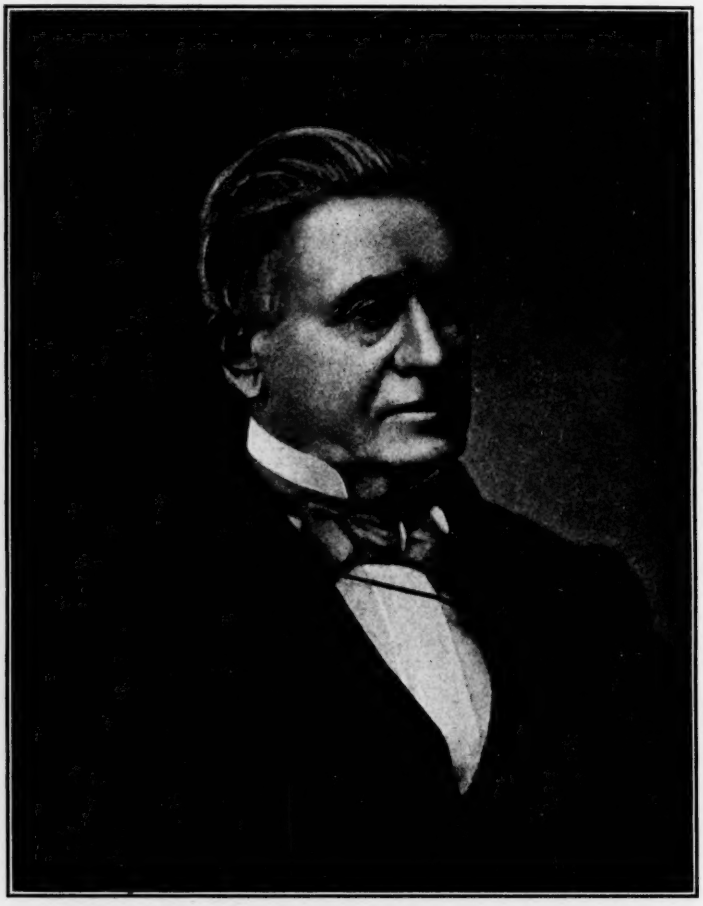
THE PROGRESS OF SCIENCE

THE ANNIVERSARY MEETING OF THE NATIONAL ACADEMY OF SCIENCES

THE National Academy of Sciences celebrated the semi-centennial anniversary of its foundation on April 22, 23 and 24, exactly fifty years after its first meeting. It was a most successful meeting with the largest attendance of members in the history of the academy. There was no program of technical papers, but in its place a series of addresses. Dr. Ira Remsen, the president of the academy, at the first session read an address on the history of the academy, and then introduced President Arthur T. Hadley, of Yale University, who spoke on "The Relation of Science to Higher Education in America." In his usual happy style he traced the increased part played by science in modern education and pointed out that his father, James Hadley, taught Greek at Yale more in accord with the methods of modern science, than was the case with physics, chemistry and biology in those days. James Hadley was elected to membership in the academy the year after its foundation, followed two years later by the election of another distinguished Yale philologist, William Dwight Whitney. There were also eminent economists in the academy, and the question may fairly be raised, though President Hadley did not do so, whether it would not be better for the academy to include in its scope the philosophical, historical and political sciences, instead of confining the membership to the natural and exact sciences.

The second formal address was read by Dr. Arthur Schuster, secretary of the Royal Society of London, who discussed "International Cooperation in Research." He stated that the strength of modern science lies not so much in the production of commanding genius as in an army of competent investigators. Problems in which useful results have already been obtained by international cooperation were reviewed, but scarcely in the "great variety" promised at the beginning of the address, for only those were mentioned in which the speaker was personally interested; all those concerned with the biological sciences, and most of those concerned with the exact sciences and their applications being ignored. The three categories of scientific cooperation mentioned—namely, the agreements on units of measurement, the distribution of work between different nations for ecenomy and the making of similar observations with similar instruments—cover but a small part of the field. Still the subjects reviewed—the Star Catalogue; the International Catalogue of Scientific Literature; Geophysics, and the Solar Union—illustrate sufficiently the advantages, and, it may be added, the difficulties, of international cooperation. Dr. Schuster perhaps went out of his way to ridicule the Belgian scheme for international associations and is too hopeful as to what the International Association of Academies may accomplish. Academies, national and international, must be placed on a representative democratic basis before they can represent the scientific men and the scientific work of the nation or of the world.

The two other addresses were on special scientific problems to which their authors have made distinguished contributions. Dr. George E. Hale, director of the Mt. Wilson Solar Observatory, had as his subject "The Earth and Sun as Magnets"; Dr. J. C. Kapteyn, director of the astronomical laboratory of the University of Groningen, "The Structure of the Universe." Both of these addresses



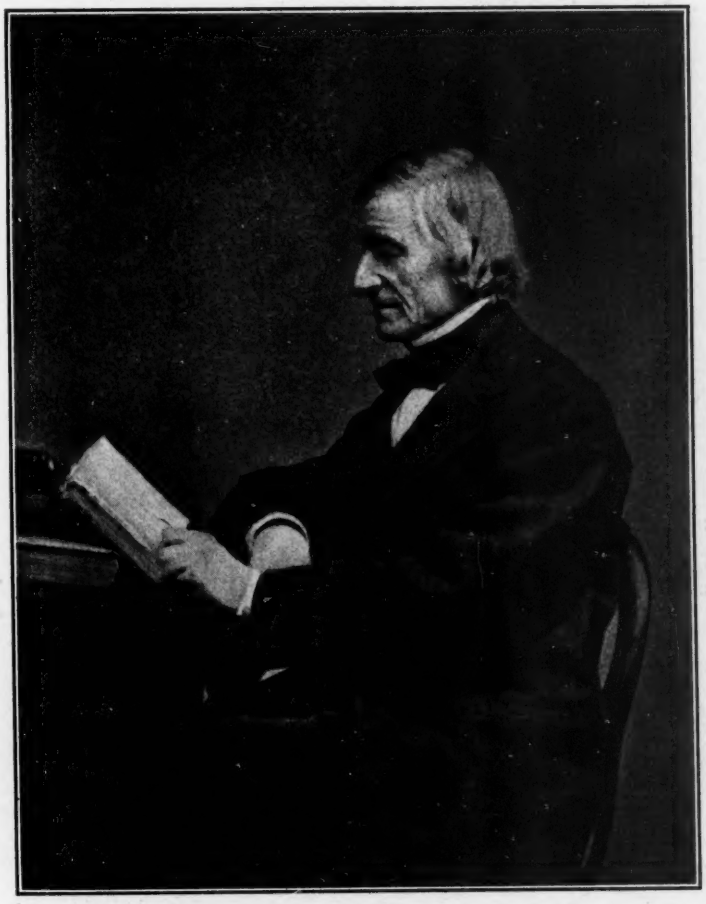
Joseph Henry

treated with admirable clearness wide-reaching theories to which the writers had in large measure contributed both the facts and the deductions. Dr. Hale's address will be printed in THE POPULAR SCIENCE MONTHLY. The other addresses have been or will be printed in *Science*.

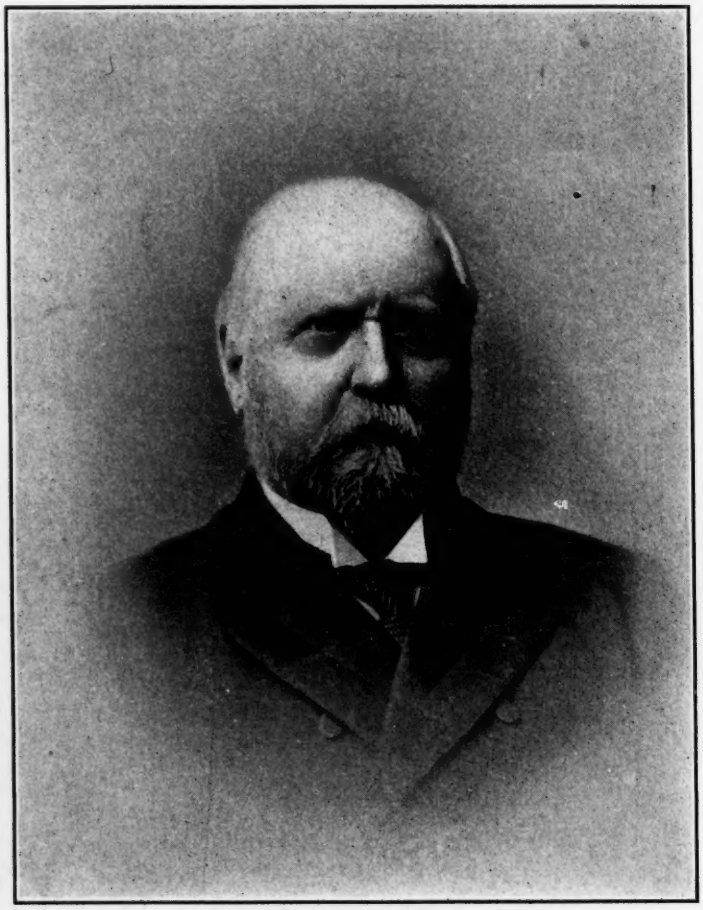
Dr. Theodor H. Boveri, of the University of Würzburg, was to have spoken on "The Material Basis of Heredity," but was unable to be present owing to ill health. Otherwise the program would have represented education and the sciences of conduct, the organization of science, and the exact and biological sciences, with two addresses from home and three addresses from abroad. The fact that three out of the four addresses were given by men working in astronomy and geophysics represents a real popular interest, though perhaps a survival from a more superstitious period, when the

motions of the stars were supposed to exert more control over human welfare than, for example, the prevention of disease by scientific research.

The program left ample time for social events, which were admirably arranged. Luncheons were provided each day and there were evening receptions at the National Museum and the Carnegie Institution. The afternoon of April 24 was devoted to an excursion to Mt. Vernon on the U. S. S. *Mayflower*. On the afternoon of April 23, there was a reception at the White House, when the President of the United States conferred medals, and afterwards, with Mrs. Wilson, received and entertained the members of the academy and their guests. The Watson medal for astronomical research was presented to Dr. J. C. Kapteyn, the Draper medal for astrophysical research to the French Ambassador for M. Henri Deslandres, the Agassiz medal for oceanographical research to the Norwegian minister for Dr. Johan Hjört, and the Comstock prize of the value of $1,500 for research in radiant energy, to Professor R. A. Millikan, of the University of Chicago. At the dinner on the evening of April 24 speeches were made by the vice-president of the



William B Rogers



O. C. Marsh

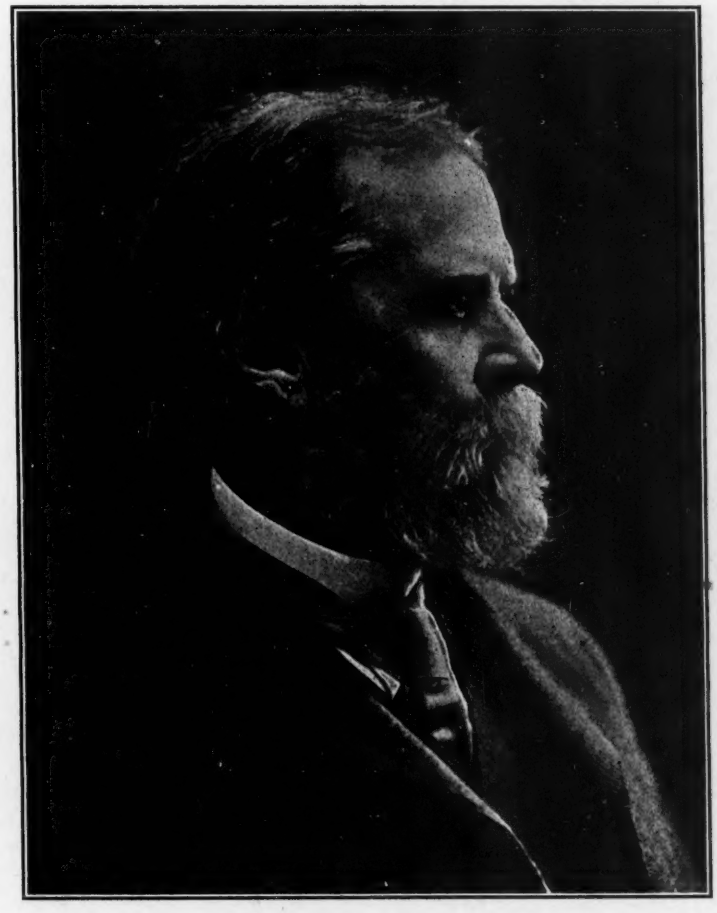
United States, the British Ambassador, Dr. S. Weir Mitchell, Dr. W. W. Keen, president of the American Philosophical Society, and Senator Burton.

THE HISTORY OF THE NATIONAL ACADEMY

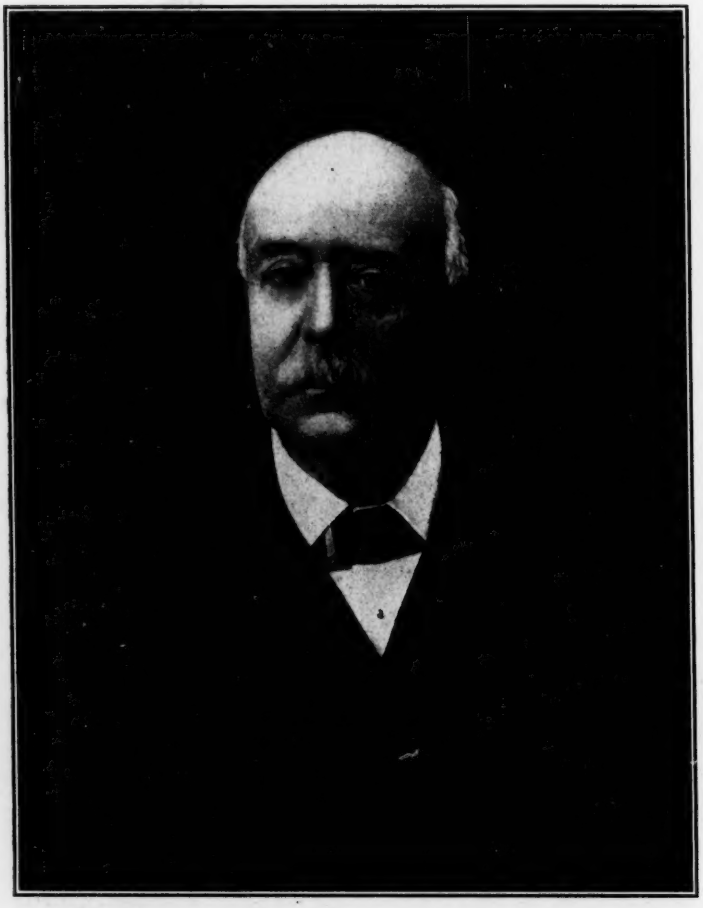
THE National Academy of Sciences was founded under the shadow of the civil war in order that the government might have the benefit of expert scientific advice and—as has usually been the reward of scientific research—obtain it free of cost. In February, 1863, the secretary of the navy appointed a "permanent commission," consisting of Joseph Henry, secretary of the Smithsonian Institution; Alexander Dallas Bache, superintendent of the Coast Survey, and Charles H. Davis, chief of the Bureau of Navigation, to report on "matters of science and art." This commission led to the establishment of the National Academy of Sciences through a bill introduced in the senate by Henry Wilson, of Massachusetts, on February 20, 1863, and signed by President Lincoln on March 3.

The idea of a national academy was

not new; it had, for example, been advocated by Bache in his presidential address before the American Association for the Advancement of Science in 1851. Such academies existed in each of the great foreign nations and had been important factors in the advancement of science, through their relation to the government and in other directions. The Royal Society of London celebrated last year its two hundred and fiftieth anniversary; the Academy of Sciences of Paris was established at about the same time; even earlier there were academies in Italy. The members of the continental academies receive salaries; the British government at least provides the Royal Society with a house. In this country the American Philosophical Society, modeled by Franklin on the Royal Society, and the American Academy of Arts and Sciences, modeled by Adams on the Paris Academy, have long histories. If Philadelphia had remained the seat of government, the American Philosophical Society would doubtless have performed the functions of a national academy.



Willard Gibbs

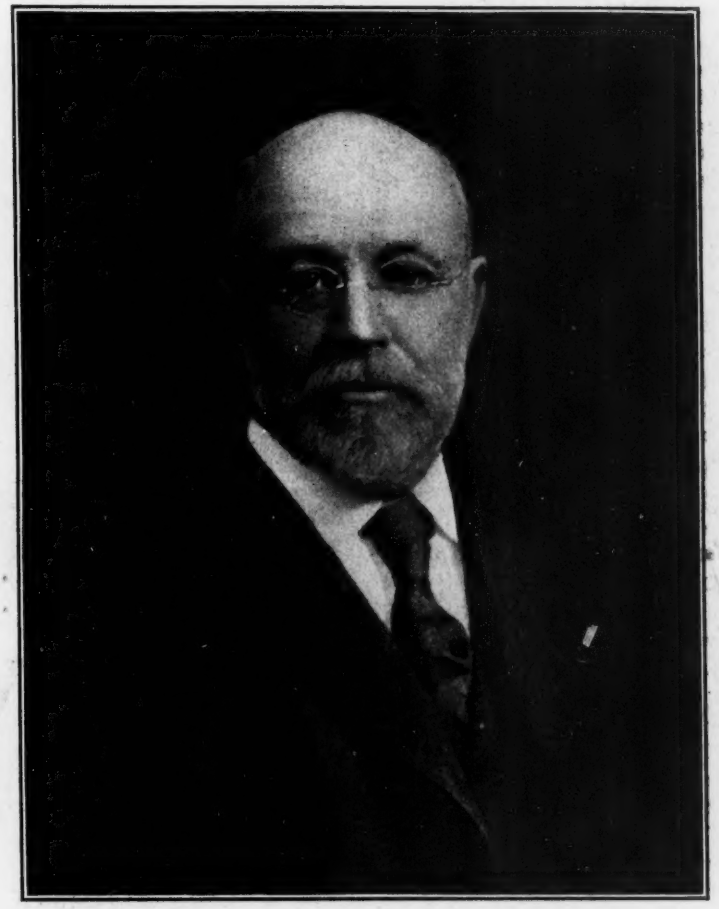


A. Agassiz

There were fifty original members of the National Academy and until 1870 the membership was limited to that number. The first meeting was held at the University of the City of New York, now New York University, on April 22, 1863. The officers were: president, Alexander Dallas Bache; vice-president, James Dwight Dana; foreign secretary, Louis Agassiz; home secretary, Wolcott Gibbs; treasurer, Fairman Rogers. The academy was divided into two classes, one for mathematics and physics, of which Benjamin Peirce was chairman and Benjamin A. Gould secretary, and one for natural history, of which the elder Benjamin Silliman was chairman and J. S. Newberry secretary. It is doubtful whether the academy could now elect officers who fifty years hence would be equally distinguished.

Immediately after its organization the academy was called upon to appoint committees to advise the government, five such committees being named within a month. The first of these was on uniformity of weights, measures and coins considered in relation to international commerce. This committee ultimately reported in favor of making it lawful to use the metric system and

to authorize its use in the postoffice and this recommendation was enacted into law by the congress. Other committees, as on protecting the bottoms of iron vessels and on magnetic deviation of iron ships, were directly concerned with the conduct of the civil war. As the scientific bureaus of the government developed there became less need of committees of the academy for investigation, and, as the president pointed out in his introductory address at the recent celebration, the government has in recent years but rarely called on the academy for its advice. The last time the academy acted was in pursuance of a request by the congress in 1908 to report on the methods and expenses of conducting the scientific work under the government, but the recommendations of this committee appear to have been ignored. There is reason to believe that while committees for conducting scientific experiments are no longer needful, the disinterested advice of a body such as the National Academy in the selection of the heads of the scientific bureaus under the government and the conduct of their work may be recognized. The officers elected



Ira Remsen

at the recent anniversary meeting—Dr. William H. Welch, professor of pathology at the Johns Hopkins University, president; Dr. Charles D. Walcott, secretary of the Smithsonian Institution, vice-president; and Dr. A. L. Day, director of the Geophysical Laboratory of the Carnegie Institution, home secretary—promise an administration under which the advice of the academy may be of service to the government.

On the occasion of the fiftieth anniversary there has been published a history of the first half century of the academy, prepared and edited by Dr. Frederick W. True, assistant secretary of the Smithsonian Institution under the charge of a committee of which Dr. Arnold Hague, the home secretary, was chairman. From this volume we take the portraits of the seven distinguished men of science who have successively been presidents of the academy.

SCIENTIFIC ITEMS

WE record with regret the death of Dr. Lester F. Ward, professor of sociology at Brown University, formerly paleontologist of the U. S. Geological Survey, and of Professor William Morris Fontaine, for thirty-one years professor of natural history and geology in the University of Virginia.

UNDER the present admistration Dr. B. T. Galloway, chief of the Bureau of Plant Industry, has been appointed assistant secretary of agriculture and Professor Adolph C. Miller, who holds the chair of economics and commerce in the University of California, first assistant secretary of the interior. Dr. Hugh M. Smith has been promoted to be commissioner of fisheries. Dr. John Bassett Moore, professor of international law and diplomacy in Columbia University, has been appointed counsellor to the department of state.

THE National Academy of Sciences has elected the following new members: Henry Andrews Bumstead, professor of physics, Yale University; L. E. Dickson, professor of mathematics, University of Chicago; Ross G. Harrison, professor of comparative anatomy, Yale University; Gilbert Newton Lewis, professor of physical chemistry, University of California; A. O. Leuschner, professor of astronomy, University of California; Lafayette B. Mendel, professor of physiological chemistry, Yale University; George H. Parker, professor of zoology, Harvard University; L. V. Pirsson, professor of geology, Yale University; Edward B. Rosa, chief physicist, Bureau of Standards; Erwin F. Smith, pathologist in charge, Bureau of Plant Industry, U. S. Department of Agriculture.

THE American Philosophical Society at its stated meeting on April 19 elected the following members: Dr. George F. Atkinson, professor of botany, Cornell University; Dr. Charles Edwin Bennett, professor of the Latin language and literature, Cornell University; Dr. John Henry Comstock, professor of entomology and invertebrate zoology, Cornell University; Luther P. Eisenhart, professor of mathematics, Princeton University; George Washington Goethals, U.S.A., chief of engineers of the Panama Canal; William Crawford Gorgas, assistant surgeon general, U.S.A.; Dr. Ross Granville Harrison, professor of comparative anatomy, Yale University; George Augustus Hulett, professor of physical chemistry, Princeton University; Dr. Clarence Erwin McClung, professor of zoology, University of Pennsylvania; John Dyneley Prince, professor of Semitic languages, Columbia University; Dr. Samuel Rea, president of the Pennsylvania Railroad Company; Dr. Henry Norris Russell, professor of astronomy, Princeton University; Witmer Stone, curator of ornithology of the Philadelphia Academy of Natural Sciences. Three foreign members were elected as follows: Sir Arthur John Evans, keeper of the Ashmolean Museum, Oxford; Sir Joseph Larmor, Lucasian professor of mathematics, Cambridge; and Dr. Arthur Schuster, secretary of the Royal Society, London.

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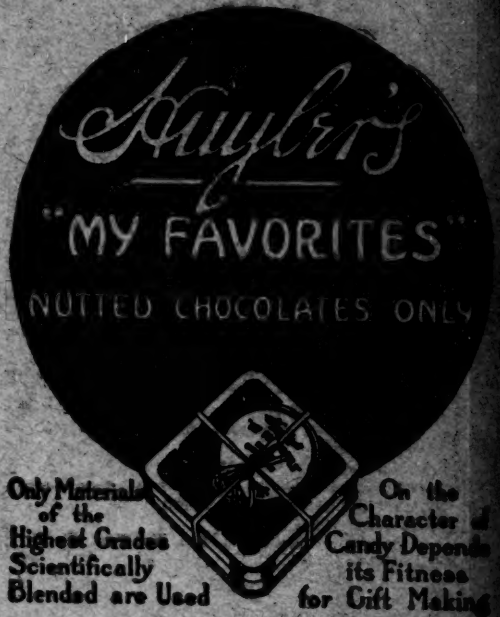

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